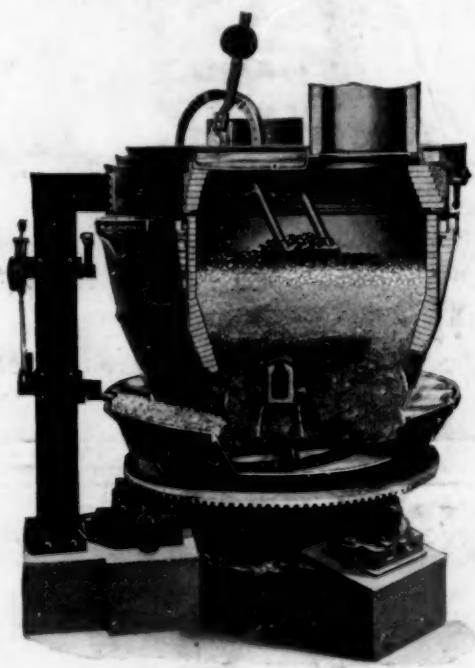


CHEMICAL & METALLURGICAL ENGINEERING

McGraw-Hill Co., Inc.

October 25, 1922

25 Cents Per Copy



RELIABILITY

That supreme quality which outvalues all others where continuous operation is imperative, without delay or breakdown. There is no apparatus in a Steel plant,

and in many Chemical and Metallurgical industries, where such reliable service is more essential than in the gas-making equipment, yet it is conspicuously lacking in most cases.

For 10 Years The Morgan Pokerless Producer-Gas Machine

has been making firm friends wherever installed, principally by reason of its absolute reliability. It is the one exception to the general experience with Gas Producers in this respect.

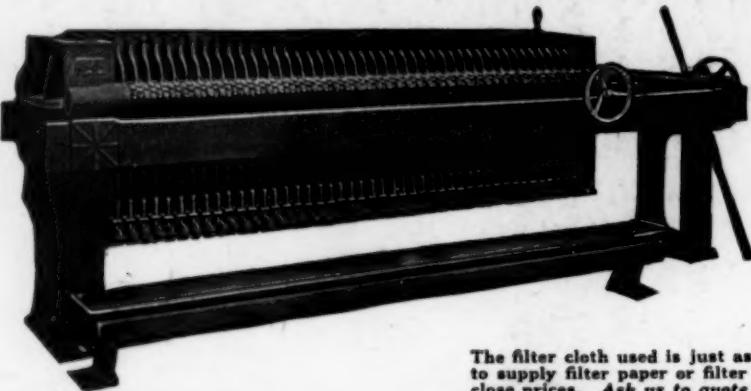
Five Hundred in Operation

Morgan Construction Company
Worcester

Massachusetts

Pittsburgh Office: 610 Magee Building





Shriver Efficiency

Many years of producing filter presses for all types of filtration work enable us to guarantee the results.

This guarantee of efficiency goes with every filter press we sell—we know our product, and we are ready to stand back of it. Write for catalog, stating your filtration problems.

T. SHRIVER & CO.

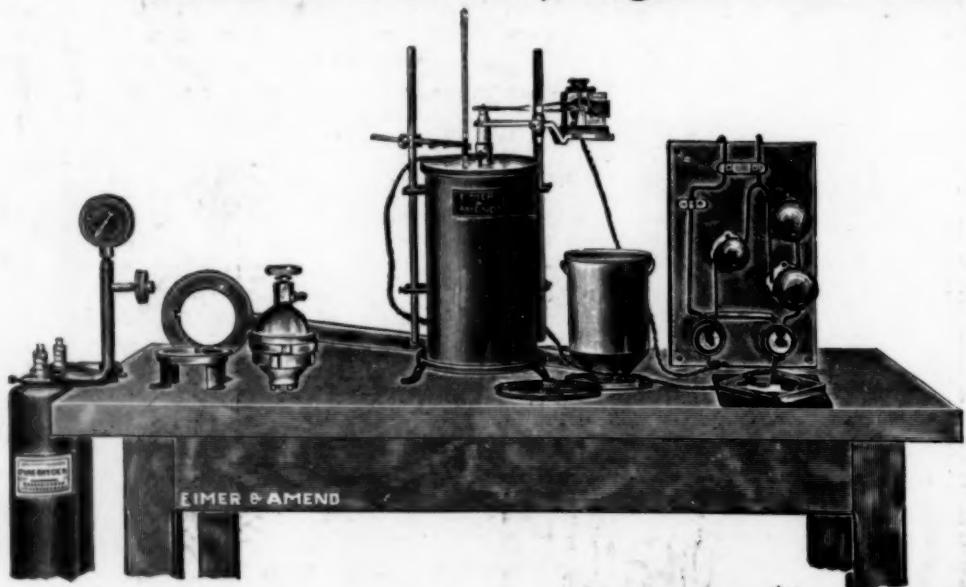
808 Hamilton Street, Harrison, N. J.

The filter cloth used is just as important as the filter press. We are in a position to supply filter paper or filter cloth especially woven for filter press work, at very close prices. Ask us to quote on your filter cloth requirements.



Standard Bomb Calorimeters

Emerson and Parr, Regular and Adiabatic



The Emerson bomb is lined with Nickel, Monel metal, Gold or Platinum. The Parr has the entire bomb of acid resisting Illium metal.

Write for Calorimeter section of our catalog and state your requirements.

EIMER & AMEND

ESTABLISHED 1851

Headquarters for Laboratory Apparatus and Chemicals
New York City, 200 E. 19th St.

Washington, D. C. Display Room
Evening Star Building

Pittsburgh Office:
4048 Jenkins Arcade

CHEMICAL & METALLURGICAL ENGINEERING

HILLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
ALAN G. WIKOFF
Industrial Editor
J. S. NEGRU
Managing Editor

R. S. McBRIDE
SIDNEY D. KIRKPATRICK
A. E. BUCHANAN, JR.
GRAHAM L. MONTGOMERY
CHARLES WADSWORTH, 3D
CHARLES N. HULBURT
Assistant Editors

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

Volume 27

New York, October 25, 1922

Number 17

German Reparations

And the Chemical Industry

SOME years ago there was a question which agitated the American people: "How old is Ann?" The answers varied from $\sqrt{3}$ to 1,087. New problems have come, but none with the same popular appeal. One question has, however, interested serious thinkers in recent months: "How much can Germany pay?" The answers vary more even than those to the earlier question. Individuals get so involved that they lose their perspective.

Therefore the speech of Sir REGINALD MCKENNA before the American Bankers' Association shone like a beacon light among the murky thoughts on this subject. The trouble with previous investigations, said the distinguished visitor, is that they have studied rather the question, "What wealth can Germany produce?" than "What amount can Germany pay as foreign debt?"

The ability to pay a foreign debt depends on two things: first, the extent of foreign investments and, second, the surplus of exports over imports. At the present time Germany has no export surplus. This is due to many circumstances, partly to the limiting of foreign markets on account of prejudice, tariff and embargo; partly to the loss of the productive areas, Silesia, Alsace-Lorraine, and the Sarre, which means inevitably more importing than formerly. But an export surplus is not now available for reparations.

Foreign investments Germany has, or rather the people of Germany have them individually. They have resulted largely from the sale of goods and of German marks in foreign countries. These investments could be sold to the German Government, which then could turn them over for reparations. Roughly a billion dollars could be realized. But is Barkis willin'? Would a German sell a foreign investment for German marks even with the mark more valuable in Germany than out of it? Sir REGINALD MCKENNA believes that he would. He believes also that if the demand for reparations should cease for three years after the foreign investments had been turned in, the mark would appreciate and that thereafter a definite annual payment could be made.

This is an economic message from a wise business man. There is no question that Germany should pay to the limit. The question is how can we get the most out of her. Sir REGINALD looks at economic facts dispassionately and therefore his message is timely. He dismisses the accusation that the German Government has not acted with firmness and good faith in taxing the people sufficiently, by saying that increased taxation does not increase foreign trade. Payment of reparations is possible only with increased foreign trade and an export surplus.

This has a significant message for all of us. No economic unit can be destroyed from this civilization without serious menace to every other unit. The whole structure is organically one, and a defection on the part of one injures all. This civilization is precisely analogous to the human body. The next fact to face is that Germany must be brought back to health not because of deserts or of misplaced humanity, but because if she dies we suffer severely and perhaps die too. A few years more of paralyzed Germany would be fatal and the only beneficiaries would be the speculators—the wolves of business.

So if we are to bring Germany back to health we must prepare for competition. More specifically, the American chemical industry should and must prepare for competition. A healthy Germany means an active chemical industry. There are happy examples of American firms which have competed with Germany under the most unfavorable conditions. It can be done. Is there enough of the pioneer left in the rest of us to do it?

The War

Department Survey

AN OFFICIAL COMMUNICATION from the Medical Department of the Army announces that as a part of a comprehensive study under the direction of the Assistant Secretary of War an investigation will be made of sources of supplies needed in that department. Not only is the Medical Department concerned with the provision of the personnel necessary for the treatment of sick and wounded, but it is also charged with the supply of the necessary materials. Therefore it will be necessary, first, to undertake a careful determination not only of the items needed but of the quantity. Second, a roster must be compiled of the personnel skilled in the manufacture, inspection or purchasing of the various commodities and third, a study must be inaugurated of the facilities of the country to produce the essential and important items of supplies.

It is an effort to do beforehand what was attempted after the declaration of war in 1917. The plan is excellent, progressive, businesslike. It will have vital interest whether any national emergency arises or not. A survey of this kind gives a vast amount of valuable data which should be available not only to the War Department but to industry in general.

Take, for example, a simple list of the commodities needed in modern surgery and medicine, together with an estimate of the quantities which would be consumed in an emergency. Such a list would be very illuminating to the chemical industry of the country and would make available better and more extensive supplies of hundreds of articles. How many plants there are anxious to extend their field of manufacture, yet unable to determine certainly what products can be desirably

produced, and for what products there would be a consistent demand?

Other phases of the survey will doubtless be retained in the secret files of the War Department, and quite rightly so. A committee of the American Chemical Society would be appropriate to discover what chemists and chemical engineers in the country have had experience in the manufacture of the drugs and chemical products required for army medical work. Such a committee would be well equipped to weed out the ambitious youngster who had his eyes on high rank in case of national emergency and had overrated his ability and experience. The American Chemical Society is the appropriate medium through which action should be taken as far as the trained personnel for the production, purchase and control or inspection of these commodities is concerned.

The co-operation of the chemical industry, individually and collectively, will undoubtedly be assured the War Department in its far-sighted work. Our congratulations are extended to those responsible for its institution.

The Measure of Efficiency And the Creative Impulse

IN OUR Exposition number, issued August 30, appeared an article by WALTER POLAKOV, entitled "Measuring Administrative Efficiency." The author described the use of the now justly famous Gantt chart as an administrative aid. With a properly designed chart, the executive can follow the efficiency of man, machine or organization. In every chart the ideal or normal performance of the man or machine or organization is indicated by a line, and exactly parallel to it is the actual performance of the individual or unit. Thus, the man or the operator has before him the perfect performance and is striving constantly through interested effort to find what means can be adopted to lengthen the line of his own performance. So the chart can mean much more than a mere historical record of accomplishment; it conveys a definite message of inspiration. It appeals to and awakens the creative impulse in the operator. In satisfying that impulse it accomplishes the impossible, especially when the work is routine, for routine kills the creative impulse. Is it possible that here is a medium which would act as the leaven of modern industry, re-inoculating its mechanism with some of the old artisan spirit, which places achievement above returns and the task well done as the ideal of accomplishment? Perhaps!

But there are two great stumbling blocks that must be recognized and removed. The first is in the application of the principle itself. Unless such charts are installed by experts who are more than experts, men who are genuine humanizers with a keen insight into human psychology and human aspirations, the work will fall short. They must be very deft in their charting, for there is nothing more sterile than an idea of this kind which has missed fire. Charts which do not stimulate but draw only ridicule would be worse than none. Success on the part of real experts would lure imitators, and inevitably a wild yeast of dissatisfaction and distrust would spring up.

The second and even greater stumbling block in the way of such achievement is the cupidity of manufacturers. Such a system can be "sold" to an executive or to a board of directors on a basis of increased efficiency and decreased cost, but they would be inclined to ridicule the ideals which Mr. POLAKOV's article sug-

gests. They would think it got them nothing. That they are wrong would not alter the inevitable result, for without the sympathy and enthusiasm of the management the charts could only be efficiency charts. Even as such they are remarkable, but if the other were possible perhaps it would be the millennium.

A Chemical Ghost Story Without the Ghosts

IF, INSTEAD of Prof. HENRY E. ARMSTRONG, Sir OLIVER LODGE had written the original letter, we should have had a whole company of the ghosts of dead-and-gone chemists broadcasting over the Atlantic Ocean by this time. As it is, the best we can do is to give our readers the story, and let them supply the spirits.

It begins with a letter from Professor ARMS RONG in which he asks about Dr. HENRY S. CARHART, who, in an address given in 1905 before the Electrochemical Society, mentioned two Dutchmen, VAN TREESTWIJK and DEIMAN, who did some work in 1789. He is writing on the general subject which includes this work, and he wants to get his early history straight.

The name CARHART sounded familiar to us, but we couldn't place it at the moment. The last issues of "American Men of Science" and "Who's Who in America" failed to enlighten us. But the previous issue of "American Men of Science" stated that Dr. CARHART was born in 1844, and was professor of physics at Ann Arbor. That was our cue, and straightway we repaired to the Chemists' Club in the hope of finding an Ann Arbor man. The first person we met was Professor WHITE of that university, who had arrived from Washington a few hours before and was leaving for Michigan within the succeeding two hours. Professor CARHART had died in California long ago, he said, but in reply to our question as to who might be informed about his work and his more particular interests and habits of research, he thought Professor HULETT of Princeton might know more than anybody else. They had worked together in Ann Arbor and were close friends. This was our second cue.

The next step would naturally be to write to Professor HULETT. But we had not the favor of his personal acquaintance, whereas we felt ourselves on terms of such friendship with his associate, Professor HUGH S. TAYLOR, as to seek a favor. So we ventured to ask him to ask Professor HULETT, if he would, to recall, if he could, the work of Professor CARHART and his reference to the two Dutchmen of 1789; and then to tell us about it.

Two days later the following letter was received from Professor TAYLOR:

You are the fortunate victim of a curious coincidence. As I was reading your letter Dr. HULETT was preparing a lecture on electrochemistry, and was at that precise moment reading Section 328 of Volume I of Faraday's "Experimental Researches in Electricity." He was there reading of an article by Dr. PEARSON in the year 1797 published in *Nicholson's Journal*, Volume I, pp. 241, 299 and 349. This article, given by Faraday, deals with an experiment which had been previously carried out in a somewhat different manner by the two Dutchmen in the year 1789. Had it not been for this fortunate coincidence I am quite sure that neither Dr. HULETT nor myself would have been able to help you.

There's the story; now bring along your ghosts! Unfortunately they will not perform for us, and Professor ARMSTRONG is about the last one we could imagine as sitting in a circle in the dark, singing hymns, holding hands and listening while little Eva the Indian

Maiden inspires the medium to say that she is happy, very happy. And yet, observe these leadings: the timing of the visit to the Chemists' Club, the presence of Professor WHITE, the writing to Professor TAYLOR instead of to Professor HULETT, who was interested in another problem and would not have remembered if the letter had reached him at any other time except when he had open before him Section 328 of Volume I of Faraday's "Researches." Here we have everything to make up a ghost story except the ghosts.

Salt Baths For Heat-Treating

EVERYONE knows the difficulty of heating a piece of steel to a red heat without a certain amount of oxidation—scaling or coloring—on the surface, be the heating and quenching ever so brisk. The same damage follows annealing operations, the longer time required offsetting the reduced activity of lower temperature. Such difficulties become very real indeed when one heats high-speed tools of very intricate design to just under their melting point, or fine wire (which is nearly all surface) to quite moderate temperatures. Again, delicate and expensive engraving on dies requires that such pieces be hardened without the least scaling or decarbonization.

For such work the strictest control of furnace atmospheres is required. Heating in a forge fire is of course out of the question; the best muffle furnace is none too good. Many good heat-treaters argue that the gas-fired furnace is better than those electrically heated because a "neutral" atmosphere can be more readily obtained when a violet flame is permitted to blow out the door and the gas and air are regulated for a "hazy heat." But "atmospheres" are something we don't know a great deal about, and they are very likely to play tricks on the operator—like the one who packed some tools in charcoal and annealed them just below the transformation range for several hours, only to find the surface decarbonized!

For all these reasons, metallurgists have used liquid baths of various sorts for their heating operations. Oils are suitable for low temperatures, white metals for intermediate, and lead or salts for rather higher ones. Their function is to heat the metal uniformly at a rapid rate and entirely out of contact with air. Naturally they must not react with the metal—either corroding, pitting or decarbonizing it, discoloring the surface or sticking to it so that they cannot be easily rubbed or washed off. If the bath is of salts, they must be of a nature that traces of salt escaping the washing operation will not accelerate corrosion or cause other damage. The bath evidently must have a melting point 150 deg. or so below its working temperature; it should not throw off poisonous or corrosive fumes if superheated—for that matter, copious fumes of any sort are objectionable and involve rapid wastage. It must be stable, both hot and cold, and not attack its containers. Finally, it should leave only a thin protective film on the hot steel being transferred to the quenching bath.

Such an array of requirements is so long that one would almost despair of finding a molten bath which will fill them all—especially if it is to operate over a wide range of temperature. Nevertheless the problem has been attacked, and at present several mixtures sold under trade names are available. No one of them will do everything, but it is believed that an intelligent selection will provide a set of three or four baths which will cover the range 500 to 2,100 deg. F. in a satisfactory

manner. In view of the many requirements of a good salt bath, it will doubtless be easier and cheaper for the user of small quantities to standardize on some satisfactory brand, rather than make his own.

R. B. SCHENCK and SAM TOUR have recently read interesting papers before the steel treaters, respectively discussing the art of heat-treating in lead and recounting some experiments with salt baths. Several eutectic mixtures of salts having low melting points are noted in the literature, and a number of them were tried by Mr. TOUR. In general, it was found that carbonates will either decarbonize tool steels or coat them with an immovable black layer, while sulphates (often in very small percentages) corrode metals rapidly. Nitrates oxidize the steel if operated above 800 deg. F. Satisfactory tempering baths working below this figure may be made of sodium and potassium nitrates (molecular ratio 1 to 1) or a similar mixture of sodium nitrate and nitrite. Charcoal and cyanides must be kept away from these nitrate baths, on account of the explosion hazard.

Mixtures of chlorides are ordinarily used for hardening baths. A eutectic mixture of calcium and sodium chlorides (72.5 per cent CaCl_2 by weight) melting at about 950 deg. F. is sold under different names. Such a mixture made of commercial salts must be heated to 1,600 or 1,700 deg. F. several times, else it will pit the steel. Furthermore, this pitting action persists if the salt is contained in a graphite pot! However, calcium chloride should be avoided because it is hygroscopic and a rust promotor—any fume which condenses in the building becomes sirupy and rapidly corrodes iron fixtures. Heat-treated articles must consequently be carefully scrubbed in hot sal soda and rinsed in water, to remove the last traces of the salt.

The Ford Motor Co. makes extensive use of salt baths operating at about 1,550 deg. F. for heat-treating gears. As originally made up it consists of 50 per cent sodium carbonate, 37½ per cent sodium cyanide and 12½ per cent sodium chloride. Apparently the oxidizing power of the carbonate and the carburizing tendencies of the cyanide counterbalance each other. Cyanide appears to decompose, by an obscure reaction, when its temperature reaches about 1,500 deg. F.; a bath which previously was quiet then acquires a vigorous, continuous circulation. This is of the greatest value in keeping the temperature uniform throughout the bath, even though it costs a handful of fresh salt at intervals.

Barium chloride has not the pronounced disadvantage of being so volatile, hygroscopic and a rust promotor, but it possesses a melting point (about 1,700 deg. F.) too high for any quenching baths except high-speed steel. Sodium chloride also appears to be quite harmless, when free from magnesium sulphate. A eutectic mixture of NaCl and BaCl_2 (containing 22 per cent of the former by weight and melting at 1,175 deg. F.) is probably the best home-made, high-temperature bath. Sodium chloride fumes badly at high temperatures; pure barium chloride may then be used.

As mentioned above, we now have some salt mixtures which will operate over limited ranges of temperature, and will be found to do excellent work in continuous operation. What is yet to be found is a mixture which will work satisfactorily on batches—that is, receive the work at a temperature below that which causes appreciable scale in the open air, say 1,000 deg. F., and be heated gradually to the annealing or quenching temperature. This slow heating is especially necessary on parts where growth, shrinkage and warpage must be eliminated.

Readers' Views and Comments

Technology of the Carbon-Electrode Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—In one of a very interesting series of articles regarding "The Technology of the Carbon-Electrode Industry," Charles L. Mantell in your issue of Aug. 23 makes a statement regarding the future developments of this industry. He draws attention to the fact that the National Carbon Co. is manufacturing 24-in. electrodes 180 in. long, which he believes to be the largest ever made.

In an article printed in your journal of June this year the writer was able to show that Söderberg self-baking electrodes are in operation in Europe in sizes up to 39 in. diameter and about 230 in. long. The weight of these electrodes are three to four times the weight of the mammoth electrodes of the National Carbon Co.

Söderberg's jointless electrodes have been in continuous operation in Norway during more than 3 years, during which time about 420 ft. of one electrode has been consumed in the furnace. These facts give a further look into the future of the carbon-electrode industry than Mr. Mantell has been able to offer. The "black art" is about to lose its secrecy through the possibility of affording every electric furnace man the opportunity of making his own electrode in the very furnace where the same is being used. M. SEM.

Christiania, Norway.

Chemists in Public Life

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having followed with more than passing interest the various articles on "Chemists in Public Life," I think the articles of Mr. Bolling (Sept. 6) and Mr. Cornell (Sept. 27) have digressed widely from the original point in view. I should like to ask of your readers who employ industrial chemists and analysts how much opportunity they give them to participate in any public matters that would take them, even for a day, away from their laboratory.

Having had charge of laboratories in several large industrial corporations, I have found as a general rule that they will employ as a head chemist as low a salaried man as they think can possibly get away with the work and give him as few cheap assistants as possible. In return, they expect him to develop quick, accurate routine methods for control, do research work and improve processes, analyze and pass upon all raw materials and finished products. In other words, a responsibility is placed upon him as great as any in the factory.

Most chemists will conscientiously try to do what is required. In order to do this, they must work out methods after hours, digest a quantity of chemical literature to keep up with the rapid progress of the science, attend society meetings, etc. When do they get the opportunity to interest themselves in public life? Only a few corporations give their chief chemist a place on their executive council. He seldom knows what improvements or changes are contemplated. Then, at a moment's notice, he must select materials and work out

new methods. Oftentimes he does not know the exact purpose for which the raw materials are to be used and is given no opportunity to follow through the process. If he insists upon knowing and seeing just how the materials are used, he is often told his place is in the laboratory; they can take care of the manufacture and he is only "butting in" and interfering with production. Still, if the material fails, he is responsible. Just about the time he has routine methods established and has broken in an assistant on whom he can rely, the assistant leaves, because he cannot obtain the salary he has become worth.

Then a Mr. Cornell comes along with a rush analysis involving \$1,000 or \$10,000 worth of material. The chemist knows that if the material is not up to specifications he will have to buck the laboratory of the manufacturer. He knows he will have to be right and he knows that a correct analysis cannot be made inside of 3 days, and it is wanted in 3 hours. If he rushes through an analysis and is wrong, he loses his position and, what is more, his reputation. A good chemist simply cannot be rushed beyond the degree of accuracy he knows he must attain.

I have found chemists as a rule to be just as human and just as much interested in public affairs as any other class of men. Mr. Bolling may prefer pure science, and the pure scientist has his allotted part in the general advancement of the world, but I do not think his ideas are representative of chemists as a whole.

What Mr. Redman says (Aug. 16) about applications from students for laboratory work is undoubtedly true. But after they are employed in the laboratory, do they have the opportunity to see and know what their work pertains to and become interested in applying their technical knowledge at some point of production or manufacture? Or are they so rushed with routine that their only thought is to catch up with the mass of work ahead and get enough experience to go somewhere else and obtain a better position?

At one time I was in charge of a laboratory for a company which made a practice of starting a man on routine laboratory work, fitting him technically for a plant position, and then giving him an opportunity to make good. Of many, only one man refused to leave the laboratory and only one failed to make good in an executive position in the plant.

It is not the chemist who makes a hermit of himself, but the manufacturer who forces the chemist to become a hermit. Let those who employ chemists give them a business standing with the company in accordance with the value of their work, give them an opportunity to meet, associate and consult with executives and they will soon discover that their most valuable executives have been drawn from the technically educated men who may have started in the laboratory.

Once the chemist feels that he dare leave the laboratory for a few hours without things going wrong, that he can afford to attend a public meeting in place of a chemical one, that he does not have to eat, drink, sleep and think chemistry 24 hours a day in order to keep a

laboratory going that is woefully undermanned and underpaid, he will gladly interest himself in public life and no doubt prove as efficient there as he already has in industrial work.

DELOS N. HICOK,

Research Chemist for the
Federated Engineers Development Corporation.
Jersey City, N. J.

Proteins and the Theory of Colloidal Behavior

To the Editor of Chemical & Metallurgical Engineering

SIR:—Replying to the letter of Dr. John Arthur Wilson in your issue of Sept. 27, I can only ask that those interested read Dr. J. Loeb's book and then read my criticism of it published in your issue of Aug. 23. Some of the questions involved will also be treated more at length in my forthcoming A.C.S. monograph on Glue and Gelatin. Dr. Wilson's statement that I have "failed to grasp Loeb's ideas" is in a way a comment on the book, because throughout my criticism, to avoid possibility of error, I quoted Loeb's own words.

Though I had selected ten points for adverse comment, Dr. Wilson takes up only one, saying that "Loeb's theory is quite independent of this assumption [that gelatin is a definite chemical entity]; it assumes only that a highly ionizable chloride of gelatin is formed when gelatin is brought into contact with an aqueous solution of hydrochloric acid," etc. To the ordinary chemist the statement that gelatin forms gelatin chloride and sodium gelatinate involves the assumption that gelatin is a definite chemical entity—otherwise we might talk of apple pie chloride and sodium tobacconate; and this assumption is with others involved in the Donnan theory of membrane equilibria, the applications of which, by Prof. H. R. Proctor, Dr. J. A. Wilson and their followers, have been supported and praised by Dr. Loeb. To those acquainted with the literature, it seems that gelatin is not a definite chemical entity—see, e.g., Bogue's recent book.

All theories must perpetually run the gantlet, and one adverse fact may bring destruction. The upholders of the theory cannot then take the position of the Irishman who, when confronted by a witness of unquestionable character who saw him steal the pig, said: "Sure, that's nothing. I can bring in twenty men who'll swear they never saw me take it."

Far be it from me to deprecate the excellent work done by Professor Proctor, Dr. Wilson, Dr. Loeb and their co-workers, even though I may take exception to some of their details and conclusions. And much praise is due to the Gallun Co., with which Dr. Wilson is connected, for its generous support of the work of Prof. A. W. Thomas and others at Columbia University. But when Dr. Loeb says (p. 278): "There is only one source of colloidal behavior—namely, the Donnan equilibrium—at least as far as the proteins are concerned," it is time to stop and consider. There comes to mind such a possibility as gelatin having a more or less definite average adsorptive surface which need not be identical with the possible stoichiometric surface.

Dr. Wilson, in speaking of "the flight of imagination of those who have tried to dodge the mathematics of the Donnan equilibrium," falls into the very pit warned against in my criticism: "The great danger in applying mathematics to chemical and physical problems lies in the fact that we may be blinded by the logical perfection of this mere tool and make erroneous assumptions, or else neglect important factors that so often crop up unexpectedly in nature." It is not the algebra and

calculus to which exception is taken, but the chemical and physical assumptions which underlie them, and without which they could not function or exist.

JEROME ALEXANDER.

New York City.

EDITOR'S NOTE—We knew there would be trouble a year and a half ago when, at the Chemists' Club celebration, Dr. Loeb brought out his observation that, so far as proteins were concerned, the measure of adsorption may be determined by hydrogen-ion concentration. This seemed to indicate that the so-called phenomena of adsorption are really chemical phenomena rather than a kind of colloidal plastering—at least, so far as proteins are concerned. It is the thesis of his important and very interesting book.

His findings are contrary to the conclusions heretofore current in regard to colloids, and many chemists who have worked long and ardently within the domain of colloid chemistry feel that Dr. Loeb must be wrong. They stand pat on earlier observations and conclusions. Among these we may include Mr. Alexander. Dr. Wilson, among others, thinks Dr. Loeb is right and that he has blazed the trail to great enlightenment in this work. Each expresses his opinion with some gusto. We shall close the discussion in these columns for the present by leaving it open.

Inadequacy of German Press Subsidy

The German press, which has weathered numerous financial and economic difficulties in the past year, has succeeded in obtaining only partial relief through the passage of a subsidy law effective July 21, 1922, says *Commerce Reports* of Oct. 2. The hopes of receiving immediate financial assistance, which it was thought this new relief measure would provide for, have been shattered. It is stated that it will be months before the proposed machinery will be in operation, which, of course, will be too late to prevent many papers from closing down. The press also complains that the funds which are to be raised by this subsidy will be wholly inadequate for their needs. For instance, the German press is to receive 1½ marks per thousand on all export sales of print paper, but this income alone would amount to only 223,570 paper marks for the month of June, 1922, to be distributed among all German newspaper publishers. The application of this export tax at the present time is somewhat vague, as it will also possibly include paper pulp and pulp timber; however, the sum to be realized will be insufficient.

Originally it was proposed by the federal government that the various German states establish an emergency fund (*Notkasse*) whereby a tax of 8 marks per person was to be assessed, raising a fund of approximately 500,000,000 marks for the assistance of the press. This did not meet with the approval of the several states, so the Rueckverguetungskasse für die Deutsche Presse (reimbursement fund for the benefit of the German press) described in the law was established. The German press has also strenuously opposed the exportation of print paper, which is greatly needed at home. They have not, however, succeeded in obtaining a more stringent export prohibition.

As the proposed assistance is not immediately forthcoming and the relief fund will be very small, the German newspapers are compelled to increase subscription and advertising rates in order to meet their increased costs of printing, labor, freight, ink and paper.

European Conditions as I Saw Them

Impressions of Casual Travelers Are Not Always Safe Criteria
of True Industrial Conditions — Smokeless Chimneys Do Not
Mean Idle Power Plants — Examples of German Industrial
Competition and Its Effect on Business in Other Countries

BY J. S. NEGRU

IN A previous article I outlined what I regard as the fundamental cause of the turmoil now prevailing in all European industrial countries and particularly in Germany—namely, that the Germans have lost the economic war which they have been waging for nearly the past 3 years against all the other industrial countries. This is a sweeping statement as to cause and effect, and so different from those made by the Germans themselves, by casual travelers and by omniscient personages here and there, that strong proofs are required before it can be accepted.

No doubt many others would arrive at the same conclusion as I have were they to give due thought to an analysis of the question, What has become of the fruits of Germany's very intensive and steady production during the past 3 years? For the benefit of those who do not feel disposed to undertake such an arduous task, I will endeavor in what follows to point out some of the striking facts that contributed to my conclusion.

MISLEADING IMPRESSION

Impressions of Germany from casual travelers are now regarded as good copy by newspapers and literary magazines. Many of them carry in each issue more or less of this material, and even some technical papers get hold of it and print it in good faith. But the trouble with most of this material is that it represents one or two isolated observations which are not typical of general conditions, although assumed to be such. As an example I may cite the following fact, which, had it come to the notice of the casual traveler, would have given another twist to his impressions.

On March 16, 1922, I went to the office of H., located on the corner of Friedrichstrasse and Leipzigerstrasse, Berlin, which as to traffic can compare somewhat with that of New York City at the corner of Broadway and 42d St. In order to cross Friedrichstrasse I had to pass a temporary wooden crossing, as the street was all torn up, a subway being built, the roof of which was at most 3 ft. from the surface. The first impression I got from this sight was much to the advantage of the municipal government of Berlin, which, I thought, although confronted with the fact that citizens were struggling for the necessities of daily life, was still able to get together large sums for public utilities. The impression was fine.

CORRECTED IMPRESSION

On the 18th of May, two months later, after having visited other German, Belgian and French districts, I was again in Berlin and made another trip to the above-mentioned office. The temporary wooden crossing was still there, the street was torn up as before, and the few workmen that I could see on both sides of the crossing—I counted six—were busying themselves in a way that reminded me of a high-speed movie film slowed down in order to give opportunity to observe every detail.

This is the second of a series of articles by Mr. Negru on this subject, the first of which appeared in last week's issue.

And as for my first impression that Berlin was still keeping up with public improvements and the construction of public utilities—it naturally died. I soon learned that the street had been torn up for a long time prior to March 16, when I first saw it, and that although the actual cost of filling that part of Friedrichstrasse until the city could again get money with which to continue its work would be relatively small, they preferred to impress the casual traveler with the fact that Germany was not neglecting the public utilities. This is a typical example of how badly misled the casual traveler can be when writing about Germany after a single hurried trip across the country.

WRONG IMPRESSION

It might not be out of place to cite here a typical example of the comments of some traveling impressionists.

I have before me a pamphlet which is an advance copy of a paper on European Economic Conditions, 1921-1922, by C. J. Warren, of the Remington Typewriter Co., presented May 11, 1922, at the National Foreign Trade Convention at Philadelphia. In this pamphlet, which was released for afternoon papers May 11, Mr. Warren states under the heading "Germany," page 2, that "I made it my business to note the number of chimneys smoking, and to size up in a general way the various industrial districts in that country." He goes on to say how remarkably close to the official figures was his personal guess of the present percentage of German pre-war production, all based on the assumption that smokeless chimneys imply idle plants.

SMOKELESS CHIMNEYS DO NOT MEAN IDLE POWER PLANTS

I am sure that Mr. Warren could have seen in Germany thousands of chimneys not smoking, but he and those who listened to his address or read it in the press must not forget that smoking chimneys make a very poor showing for good power plants. And we all know well that there are many excellent power plants in Germany. Ringelmann's smoke chart may still find some use in minor power plants located in this country, but few, if any, of the German plants need it now. One must not draw the conclusion that boilers are not steaming merely because stacks are not smoking.

So much for impressions and impressionists.

PLAN OF PRELIMINARY TRIPS

By giving a brief outline of my trip I will better enable the reader to follow my work while in Europe.

I arrived in Belgium on Feb. 22, 1922, and on the following day had my first interview with Octave Lepersonne, general secretary of the Association of Engineers Graduated From the University of Liège. Being myself an alumnus of this school, it was logical that I should start where I felt most at home. In the course of many long conversations with Mr. Lepersonne I obtained a preliminary impression of the industrial

and economic situation in Belgium. Further interviews with many other Belgian engineers and economists, and with Samuel Cross, acting commercial attaché of the United States at Brussels, served to corroborate or correct the impressions already received. Thus I was enabled to outline a plan for making personal observations and reaching my own conclusions. A similar method was followed in France, Italy, Switzerland and Germany, consuming my time until April 5, when I was back again in Belgium.

MAIN REASONS FOR CHANGING THE PLAN FOR SUBSEQUENT TRIPS

According to my original plans made in New York City, immediately after completing the preliminary trip just outlined I was to devote my attention to certain well-defined points, prepare articles on specific subjects while still in Europe, and make only casual trips into Belgian and other industrial districts. But while I was still in America I was quite unaware of the condition in which I would find central Europe, and consequently could not foresee that I was soon to become quite skeptical of the much-heralded European researches, great industrial improvements, and the like. Nor could I foresee that what I was really to gain during this preliminary trip was a group of impressions somewhat hazy and occasionally quite contradictory. The few impressions of which I was absolutely certain at the close of my preliminary tour were so striking, but also so devoid of what might be called legal proof, that they needed further study in the hope of gathering proofs that could be safely accepted as indisputable.

FINAL PLAN ADOPTED

Accordingly I decided to cover again somewhat the same route, conferring with some of the persons I had already met, in an effort to confirm my personal preliminary impressions. Furthermore, I wanted to get in touch with other individuals with whom, I had discovered in the meantime, it was well for me to talk. This plan was carried out, but only for Belgium, France and Germany. A second trip was not made into Italy and Switzerland. In addition I had also the opportunity to visit plants in Belgium, France and Germany. I also took part in the excursions of the Société de l'Industrie Minérale de France in the French war-devastated districts, visited the Ludwig II potash mines and works at Stassfurt in company with a group of members of the Society of German Metallurgical and Mining Engineers, assisted at some of the meetings of the Verein Deutscher Chemiker and at their exposition Achema III (Ausstellung für Chemisches Apparatewesen) on the occasion of the annual general meeting in Hamburg. Finally, I took quite an active part at Liège in the Congress of Engineers Graduated From the University of Liège, and often visited their exposition during the latter part of June and first part of July. This occupied the remainder of my time in Europe until Aug. 10, the date of my sailing for America on the steamer Lapland.

SUBSTANTIATING MY FIRST IMPRESSIONS

It was during these latter months that I was able to get additional information which, when correlated with that obtained on my first trip, comprised the sum total of what I learned while in Europe.

As an example of how the subsequent trips enabled

me to get more substantial impressions, I may cite the following: When I left Switzerland on March 14 I knew that Swiss industry was suffering much from German competition. Thus on May 30 I wrote in my diary, among other items, one about my meeting with Mr. G., a German jewelry manufacturer who was producing as rapidly as possible wrist watch locks at a cost of 15 marks apiece. These locks were sold at 80 marks apiece to a friend of his in Chaux-de-Fonds, the very center of the Swiss watch industry, whence they were exported to Sweden at 2.5 Swiss francs (over 150 marks) apiece. The explanation given for this circuitous transaction was very simple:

The Chaux-de-Fonds district enjoys a world-wide reputation as a watch-making center, hence a product from this district can find more readily foreign markets. The large amount of 80 marks he got for his 15 marks product is the result of a mutual understanding between old friends. The German manufacturer could not sell direct to Sweden because the latter is the customer of the Swiss watch manufacturer. But by selling through the Swiss dealer the German was not only able to get rid of his wares but also received in return therefor Swiss francs, which are not debased in value like the German marks.

I have no doubt that the German manufacturer regarded this as a perfectly normal and legitimate business transaction, just as he probably felt that the wage of 4.5 marks per hour, then less than 1.5 cents, which he paid to the girls in his shop, was very good for that kind of work. And as for the Swiss maker of wrist watch locks, one can readily imagine how he would fare in his beautiful Switzerland with this kind of German competition.

A TYPICAL EXAMPLE OF THE GERMAN ECONOMIC WAR POLICY

Another case which brings us much nearer home is that contained in a letter from one of our American subscribers who asked me to look into a certain matter while in Europe. I quote as follows from his letter:

"We are vitally interested in knowing why the manufacturers of the equipment required for the production of chemical pulp, principally soda or sulphate, can deliver all of the machinery required for a 30-ton daily capacity pulp mill at Madras, India, for one-fifth of the amount we must receive for American-made equipment of similar design. We feel that the matter of exchange between the countries affected is not alone responsible for this, and we wish you would have your Mr. Negru investigate the true conditions which are responsible; also have him ascertain, if possible, whether contracts taken by German firms are actually filled."

The German economic war policy, outlined in the previous article, explains clearly why the Germans offered machinery for one-fifth of the amount Americans must receive. As to whether contracts taken by German firms are actually filled, that is a question of the individual firm. The impression prevailing in Belgium and in France is that few importers are now putting much faith in the business promises of German industrials and merchants, even when such promises are given in writing.

Other articles giving Mr. Negru's impressions of conditions in Europe will be printed in subsequent issues.

Handling the Finished Products of Industry—VII

What to Observe When Studying an Existing Handling System With a View to Applying the Methods There Used in Another Plant—How These Points Are Illustrated by the Systems Described in This Series—Suggested Procedure in Layout of New Systems*

BY GRAHAM L. MONTGOMERY

IT WAS STATED in the first article of this series that the material-handling equipment available today for handling finished products brings results to those who use it which warrant study by those still using manual handling methods. These results justify the statement that the use of automatic equipment for handling finished products is a necessity for those who wish to keep costs low for competitive reasons and still to make a fair profit.

This series covers but a small part of the range of process industries where mechanical handling methods can be used. By no means all of these industries present examples of material handling worthy of study. The examples which are presented serve to demonstrate clearly the important points to be observed in such a study. We shall list these points and show how their observation can be made of service in the consideration of prospective installations of handling systems.

From time to time other articles will appear in *Chemical & Metallurgical Engineering* which will describe good handling methods for finished products and illustrate the principles laid down in this series. But enough ground has already been covered to make it worth while to pause and determine the benefits which may be derived from such studies as we have been making.

PRINCIPAL ADVANTAGES DERIVED FROM FINISHED PRODUCT HANDLING SYSTEMS

Handling equipment is obviously of advantage to those who use it, or its use would not be continued. The sane business man places no equipment in his plant from aesthetic considerations. Each piece of apparatus must earn its keep. It is only reasonable to suppose that the advantages derived by the present users may also be realized by many others who do not as yet use this equipment.

There are many advantages which automatic handling of finished products gives. Of these there are three which appear in every system. These are:

1. The amount of non-productive labor is decreased.
2. The speed of the product in its movement through the plant is increased.
3. The burden of management is decreased.

If, in the attempt to decide whether or not to install a material-handling system, a study is made of existing installations in similar industries, these three points should be kept in mind. The study should be made with a view to determining how and to what extent these advantages are attained in the installation studied and whether the means by which they are obtained can be applied elsewhere.

HOW TO STUDY EXISTING HANDLING SYSTEMS

The key to all handling systems is the flowsheet. As a method of procedure, then, a flowsheet should be

drawn for each handling system which is to be studied, starting at the point where the manufacturing process is completed and tracing out the path that the product is to follow from that point until it leaves the plant. These flowsheets should be drawn in both plan and elevation. From them can be determined whether the product flows in a straight and continuous manner and whether the system used is the most economical possible.

The flowsheet plan will show the path the product flows, bringing out any crossings, interferences or breaks in the flow. The flowsheet elevation shows the amount of power required to operate a system as compared with any other system by giving a measure of the lifts. This elevation also shows the advantage taken of gravity flow. On these considerations rest the comparative simplicity and economy of a handling installation. The fewer the steps in which the handling is accomplished, the straighter the flow, the more use that is made of gravity flow, the simpler to control and cheaper to operate will be the system.

WHERE TO SEEK A DECREASE IN NON-PRODUCTIVE LABOR

If we consider a handling system in which no mechanical equipment is employed, the most noticeable thing about it will be the large amount of labor which it requires as compared to the labor used in actual manufacturing processes. If mechanical equipment is installed to accomplish this handling there will be one of two possible results obtained: Either the same amount of product is turned out with less labor, or more product is obtained from the same amount of labor.

As an example of where these decreases in non-productive labor may be looked for, refer to the third article of the series, dealing with soap handling. It will be noticed that in the plants cited the saving in non-productive labor made varies from 30 to 50 per cent. In both of these installations, the soap must go through several processes of wrapping and packing between the completion of manufacture and the shipping platform. During these processes the same amount of labor is now used as was used before the handling apparatus was installed. Where the non-productive labor is eliminated is in moving the material from one of these operations to another. Instead of employing men to do this, the mechanical equipment effects the transfer and the labor of these men is dispensed with.

ELIMINATING NON-PRODUCTIVE LABOR IN A BRICKYARD

This same mechanical movement between operations is clearly illustrated in the ideal handling system for a brickyard described in Article V. Here, by the usual process, brick is man-handled from the kiln to the sorting department, from this department to storage, and from storage to the carrier in which it is to be shipped. In the ideal layout, conveyors dispense with all the wheelbarrow men at present used to accomplish this movement.

*Previous articles in this series have appeared in *Chem. & Met.* as follows: Article I, vol. 26, No. 18, p. 823, May 3, 1922; Article II, vol. 26, No. 19, p. 885, May 10, 1922; Article III, vol. 26, No. 24, p. 1,114, June 14, 1922; Article IV, vol. 27, No. 5, p. 199, Aug. 2, 1922; Article V, vol. 27, No. 15, p. 731, Oct. 11, 1922; Article VI, vol. 27, No. 16, p. 779, Oct. 18, 1922.

Whether the handling is manual or mechanical, about the same number of workers is employed to unload the kiln, to sort the brick, to tend the storage and to load the carriers. The elimination of the men that handle the brick between the above-mentioned workers is the means of lessening the non-productive labor and reaching a lowered cost.

In studying flowsheets for finished products, seeking means of reducing costs, the points to watch, then, are the spaces which occur between the various operations which the finished product goes through. As shown by the study of existing installations, the conveyors employed cover the movement over these spaces. A similarity in size, shape, weight and physical condition of the product handled by these systems points the way from an existing installation to the establishment of a new system.

AUTOMATIC MACHINERY ELIMINATES MUCH NON-PRODUCTIVE LABOR

Many plants are found where such operations as cutting, filling, wrapping and packing are still entirely hand operations. In a large number of such cases no machinery has yet been developed to accomplish these operations. Often the machinery successfully used in one industry can, however, be adapted to another industry.

That the use of these automatic machines pays well in decreasing non-productive labor is well brought out by the example cited in Article VI. Here it is shown how the same number of workers produced twenty-five times the amount of packaged sugar when using automatic filling machines than they formerly produced when filling these packages by hand. This decrease in filling cost may seem remarkable, but it is not at all unusual. Results at least equal to this have been accomplished by many other types of filling equipment.

When wrapping machinery is considered, we find results that produce an economy well up to this level. As a general rule, it can be stated that one man operating an automatic machine will replace from ten to twenty-five workers doing the same operation by hand methods.

STUDYING FLOWSHEETS TO REDUCE NON-PRODUCTIVE LABOR

When studying flowsheets to find the amount of non-productive labor employed, and to determine how much can be eliminated, note two things: First, whether movement between machines is all by conveyor or not, and whether these conveyors are of the most automatic type which can be used. Second, whether the operations which the finished product undergoes are done by automatic machines or not.

If the system is not as automatic as it could be, obtain the flowsheet for another and somewhat similar industry where the maximum economy seems to be attained. This will serve as a good indication of what can be expected from a completely automatic handling system in the industry which is being studied.

What Speed of Handling Accomplishes

A speedy handling system can accomplish several direct benefits for an industry. Without exception, greater speed of handling is obtained from mechanical equipment than could ever be reached by hand methods.

The advantages following attainment of speed are:

1. A clearer idea can be reached of the rate at which

the manufacturing can be scheduled and hence it becomes easier to plan the sales policy.

2. There is a much lessened possibility of any department becoming clogged with goods in process or with finished products.

3. The inventory of goods in process or completed can be kept at a lower figure, which lessens the amount of capital necessary to run the business.

4. The space required for storage throughout the plant is reduced.

5. The foremanship and inspection cost per unit of production is less—due to more product per employee and the greater capacity of oversight by inspectors.

HANDLING SPEED AND THE FLOWSHEET

The speed of handling does not directly show up on the flowsheet which is drawn from an existing system. It is a simple matter, however, to obtain this from knowledge of the total amount of product, the speed of various machines and conveyors and similar data. Comparative figures of speed in hand-operated plants are generally easy to obtain.

No figures on this subject have been brought out in the plants described in the series because of these facts. Such figures can be obtained as desired and the speed at which a new system is to operate should be so chosen as to accommodate best the manufacturing and sales department. Note that it is always possible to attain, in handling finished products, any speeds which these departments may indicate as desirable, and this with the use of existing equipment.

THE FINISHED PRODUCT AND MANAGEMENT

Among the things which management must accomplish in handling finished products are the following:

1. It must keep control of the product as it passes through the plant.

2. It must effect this passage through the plant at the least possible cost.

3. It must ascertain this cost so that the business may be conducted in an intelligent manner.

Material Handling Equipment Helps Management Control the Product

By the elimination to a large extent of the human factor in handling the finished product, the management is enabled to determine far more accurately the amount of this product which may be handled. This aids distinctly in determining the amount of the product which must be manufactured and the amount of the product which must be sold. It is obviously necessary that the management must know how much of the product to make, how much it can handle as finished product and how much it can sell, in order that the business may be conducted in an economical way. Anything that helps them determine these facts tends to make the operation of an industry more economical. The problems which constantly confront management of adjusting manufacturing to the market are much more easily solved when the human factor enters as little as may be into their considerations.

Control over the finished product as it passes through the plant must be maintained through the use of foremen and clerks. The amount of work necessary from these workers is almost directly proportional to the number of stops which the product makes, and is also influenced by the complication of the path of the product. By the use of automatic equipment and handling

machinery all stops except at storage points may be eliminated and the path may be practically a straight line.

COST ACCOUNTING AND MATERIAL-HANDLING INSTALLATIONS

The price at which a product may be sold will be a function of the cost of producing that product. This cost involves the cost of all the various processes which enter into the complete production of the article. It is the function of the cost accountant to determine these costs so that the management is enabled to act intelligently.

Power costs of a finished-product handling system are easily obtained by power input figures. The amount of labor is small and can easily be kept track of. Such items as upkeep and maintenance do not present difficulties to the cost department. The records which must be kept are simplified by the use of mechanical equipment and the burden on this department of the management is much reduced.

SOME POINTS BROUGHT OUT ON LESSENED MANAGEMENT BURDEN

In the second article of the series the point is made that in handling many food products the principal care of the management must be in maintaining sanitary conditions. Here we see the burden of management lessened by the application of this equipment, for the reason that its use eliminates the possibility of contact with human hands or other contaminating influences.

The fourth article presents an even clearer illustration of this. Here, by the complete use of automatic methods, all manual handling is eliminated. This makes the workers merely machine tenders and does away with by far the greater part of the cost for foremanship. By the use of the automatic equipment and the elimination of labor which follows, the problem of cost keeping is reduced to its simplest terms.

THE FLOWSHEET AND MANAGEMENT

After the flowsheet for the finished product has been studied and a determination has been made from it of the amount of labor which can be eliminated and of the path of flow and the speed with which the products flow along this path, this sheet may be studied with a view to determining the effect of the handling system on the management. This sheet will show the operations through which the finished products must go. It will show the number of men whose services will be involved in handling the product. It will show the points at which the products stop and any points where delay or confusion might occur.

Observing these facts, it then becomes possible to determine just what the effect of any particular system will be on the management. The amount of controlling effort necessary to guide production in accordance with the management's desires will be evident, as it is proportional to the points brought out in the preceding paragraph. The cost of moving the products can be predicted with fair accuracy and the relative difficulty with which these figures are obtained under different systems will be readily seen.

HOW TO PROCEED AFTER THE STUDY OF THE FLOWSHEET HAS BEEN MADE

In determining the advantages to be derived from the installation of handling equipment for finished products by the study of the flowsheets of existing

installations, the procedure which the writer has found to be the most advisable is as follows: Study the flow of material in several plants which are analogous to the plant in which it is desired to make a new installation. From this study determine just what the available equipment can do for you. After this determination is made, you will have certain facts in hand.

These facts will give the number of men which must be used to handle a certain product in a definite quantity by mechanical methods. They will show the path which the product must follow and will give a clear idea of the number of stops which the product must make on this path. A fairly clear idea will also be obtained of the economy effected by the use of the equipment.

With these facts in hand, we have the story of what has been accomplished by others through the use of the equipment. Lay out then a new flowsheet for the industry to which it is desired to apply the automatic and mechanical handling equipment, indicating the path which the product must take; the stops it will make and why these stops are made, naming the automatic machines and giving data on them if any are used; and giving the amount of product to be moved in a given time.

Judging a Handling System

Without indicating on this flowsheet the economies which are expected to result from the use of the equipment, it should then be submitted either to consulting engineers who make a specialty of handling layouts, or to the conveyor engineers who are in the employ of the conveyor-manufacturing companies. Supply these engineers also with such plans as are necessary to give them a clear idea of the physical conditions which will surround the handling equipment. Request them from this information to lay out an installation and to indicate on their layout the number of men and the amount of power necessary to handle the required volume of products with their system.

By comparison of the layouts submitted under this scheme with the predicted economies as shown on the flowsheets drawn for the industry and the actual economies obtained and shown on the flowsheet for similar industries, the plant which desires to install a mechanical handling system for its finished product is enabled to judge with a sufficient degree of accuracy just what benefit it will derive from installing any recommended handling system.

Dolomite for Refractories

If the lime in dolomite can be combined so as to render it non-slaking and at the same time hold up the refractoriness of the material, the abundant deposits of dolomite in the country would be rendered available for extensive use as a basic refractory, according to the United States Bureau of Mines. Briquets containing 90 per cent dolomite and varying percentages of iron oxide and clay have been burned by the Bureau of Mines at the ceramic experiment station, Columbus, Ohio. Slaking time tests were run and the results plotted on a triaxial diagram. The slowest slaking mixture was selected for making into bricks which were burned to a high enough temperature to render the lime inactive. Bricks with a high fusion temperature and high specific gravity, great mechanical strength and low porosity were the result. The work is being continued, using varying percentages of dolomite to determine the non-slaking areas over the entire field.

Refining of Salt Crude Glycerine

**The Open and Closed Distillation Systems for Dynamite Glycerine
—Manufacture of Chemically Pure and Yellow Distilled Grades—
Operating Control and Procedure—Bleaching—Foots Treatment**

BY WALTER E. SANGER
Wurster & Sanger, Chemical Engineers

THE refining of glycerine consists of the distillation of crude glycerine, together with subsequent bleaching to obtain a desired color. Dynamite grade of glycerine is usually obtained in one distillation whereas chemically pure (c.p.) glycerine requires a second distillation and, in exceptional cases, a treatment of the once-distilled stock before this second distillation.

Salt crude glycerine or glycerine obtained from spent soap lyes consists of glycerol, salt, water, fatty acids, esters and other impurities, and is sold on the basis of 80 per cent glycerol content¹. Before distillation, the crude is tested for alkalinity and sufficient caustic soda is added, if necessary, to combine with the fatty acids present in the crude in order to prevent frothing as well as excessive fatty acids in the distilled glycerine. The amount of caustic required is determined for each charge of crude—there being added an excess of caustic soda sufficient to have from 0.1 to 0.3 per cent of free caustic on a boiling test.

THE TWO SYSTEMS OF DISTILLATION

At the present time there are in general use two systems of distillation for dynamite glycerine, which may conveniently be called the open system and the closed system. The open system is one in which the glycerine and sweet water are removed from the distillation unit in order to concentrate to the desired glycerine content. The dilute glycerine (75-90 per cent) is concentrated separately to the dynamite grade, and the sweet water is concentrated separately to make a sweet water crude glycerine which may again be distilled for dynamite glycerine or may be concentrated, bleached and sold as "yellow distilled" glycerine. In the closed system, the dilute glycerine is concentrated directly in a concentrator which is an integral part of the distillation unit; the sweet water is concentrated in the sweet water evaporator (which also is an integral part of the distillation unit) to sweet water crude, or it may be concentrated in a separate evaporator.

In the necessary distillation for c.p. glycerine both systems are the same in that it is necessary to handle the sweet water separately. In the open system the dilute c.p. glycerine is concentrated in a separate concentrator, while in the closed system it is concentrated in the concentrator, which is an integral part of the distillation unit.

It is important that the pressure on the coils of the system be in excess of 140 lb. As the pressure decreases below 140 lb. the rate of distillation falls very rapidly. A high vacuum on the system tends to produce a markedly higher rate of distillation and also an im-

proved product. There are now on the market vacuum pumps suitable for glycerine distillation work which will pull a vacuum on closed suction to within $\frac{1}{4}$ in. of the barometer.

The Open System

The open system is shown in outline in Fig. 1. This cut shows the use of a preheater for the steam to be injected into the crude glycerine, although this steam is quite frequently introduced directly into the charge in the still. Where the latter procedure is followed, steam for injection is taken directly from the high-pressure line.

The preheater and still shells are of similar construction—namely, a steel vessel. Inside of the shells is a closed coil extending from the bottom to the top of the straight side, this coil also covering the bottom. These coils are of extra heavy pipe construction to withstand a pressure in excess of 150 lb. These coils are usually connected to steam traps so that full pressure is automatically carried on the coils. The still is further equipped with a steam injection pipe which is in the form of a perforated coil or cross on the bottom of the still. The preheater is equipped with a steam inlet pipe and also a steam outlet pipe which connects with the injection pipe in the still.

THE DISTILLING OPERATION

In starting operations in the plant vacuum is first pulled on the whole unit. The still is charged with crude glycerine drawn in by vacuum or by gravity to a level of about 10 in. on the straight side of the still or about 4 in. in the gage glass. When the vacuum reaches 25 in., steam is turned on the closed coil slowly until the valve is wide open. It should require about 10 minutes to open the valve completely. The closed steam is turned on for the purpose of driving off the water in the crude as well as any water remaining in the still from a previous washing.

After the valve on the closed steam line is wide open, a small amount of open steam is turned into the preheater, where it is superheated by means of the closed coil. From the preheater this open steam is drawn by vacuum into the still through the perforated pipe, which is below the level of the crude in the still. The amount of open steam to be injected will depend on the grade of crude glycerine to be distilled; this amount will usually vary from 1 to 3 lb. of steam per pound of glycerine distilled.

As distillation proceeds, more crude is fed to the still continuously in order to maintain an approximately constant level in the still. This operation is continued until the full charge for the run has been fed. The amount of crude glycerine to be fed before running down to foots will depend on the capacity of the equipment and its design. A still run may vary from 8 to 24 or more hours.

¹Lack of space precludes the publication here of technical specifications, methods of analysis, etc., for either dynamite or c.p. glycerine. For the former the reader is referred to British Standard Specifications for Dynamite Glycerine; the latter is described in the Pharmacopoeia of the United States of America, Ninth Decennial Revision (Official from Sept. 1, 1916). For a description of salt crude glycerine see "Recovery of Glycerine From Spent Soap Lyes," by Walter E. Sanger, *Chem. & Met. Eng.*, vol. 26, No. 26, pp. 1211-16, June 28, 1922.

After the full charge of crude has been fed to the still, the feed is shut off and the operation (excepting feeding crude) is continued until the foots have the desired consistency. It usually requires from 2 to 4 hours to run the foots down to "dryness" after the last of the crude glycerine has been fed.

The vapors from the still pass to a catch-all or separator, where entrained crude is separated from the vapors and is returned to the still. The catch-all has one vapor inlet and two vapor outlets, one going to each set of air-cooled condensers.

AIR-COOLED CONDENSERS

Two sets of air-cooled condensers are usually employed. These are equipped with suitable baffle plates to cause the vapors to come in contact with the outer shells. The condensers are made of light steel plate. They are usually so connected that the condensate in each pair of condensers may be tested separately and if the glycerine is of inferior quality it may be kept separate from the satisfactory distillate and so not contaminate it. There are usually four sets of air-cooled condensers to a still, or eight condensers in all. The glycerine condensed here may be run by gravity to a closed receiving tank, whence it is transferred to a storage tank previous to being concentrated to the dynamite grade in a separate concentrator.

The glycerine condensed in the first pair of air-cooled condensers is usually tested for NaCl. If it shows none of this salt, the glycerine condensed in all of the air-cooled condensers is run by gravity into the closed glycerine receiver, which is under vacuum. If the sample shows the presence of NaCl, the air-cooled condensers remain shut off from the closed receiver and all glycerine is held in the condensers. At the end of the run these condensers are sampled by pairs and all glycerine giving a test for NaCl is run to the open glycerine receiver, whence it is usually returned for redistillation. If the NaCl content is sufficiently low, this once-distilled stock may be used for making the chemically pure grade.

The amount of distilled glycerine which is condensed in these air-cooled condensers varies considerably with

the temperature of the glycerine room and is not regularly controlled by artificial refrigeration or other means. An average figure of the glycerine condensed here would be about 75 per cent of the glycerol in the original crude.

SWEET WATER CONDENSERS

The vapors which pass the air-cooled condensers go to the sweet water condensers, which are of a water-cooled surface type. Here the last of the distillate vapors are condensed to form sweet water, which is run by gravity to a closed sweet water receiver. From this receiver it is pumped to sweet water storage tanks. The amount of glycerine in the sweet water will vary considerably, but allowing 5 per cent for glycerol in the foots, this amount will be about 20 per cent of the glycerine in the original crude glycerine.

The sweet water is drawn from the storage tanks into evaporators, where it is concentrated to sweet water crude glycerine, which is again distilled to make the dynamite grade, the residue being foots, or it may be concentrated and bleached to be sold as "yellow distilled glycerine."

The handling of yellow distilled (Y.D.) glycerine and the bleaching of the dynamite grade will be discussed later under these heads.

HANDLING FOOTS AND WASHES

The vapor line between the still and the catch-all is equipped with a gate valve. This valve serves the double purpose of preventing any foots from splashing beyond the catch-all when washing out the still and also permits vacuum to be pulled on the rest of the unit while washing out.

At the end of a run this valve is closed and vacuum is broken on the unit. The sweet water and dilute glycerine are transferred from the unit in accordance with the use to which they are to be put. The valve on the bottom of the still is opened so that any liquid foots may be dropped into the foots tank. The foots tank has in it about 3 or 4 in. of water or washings from a previous run, which serves to prevent the foots as dropped from the still sticking to the tank bottom.

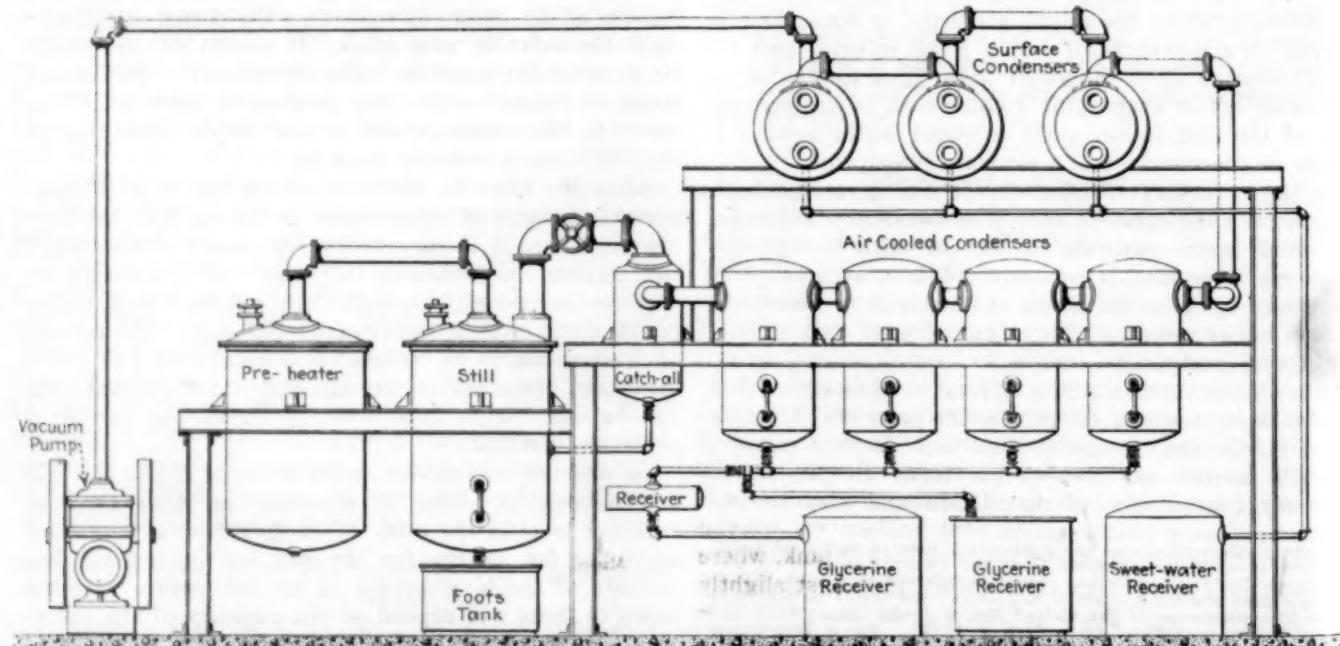
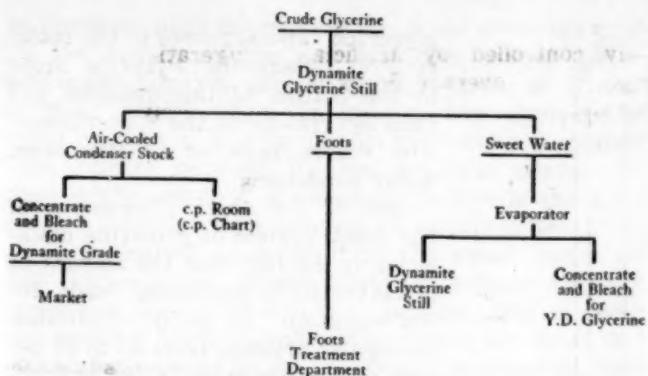


FIG. 1—A GLYCERINE DISTILLATION UNIT FOR THE OPEN SYSTEM



FLOW CHART FOR THE DISTILLATION OF CRUDE GLYCERINE TO DYNAMITE AND YELLOW DISTILLED GRADES BY THE OPEN SYSTEM

After all liquid foots has been dropped, the valve on the bottom of the still is closed.

The still is equipped with a nipple and valve which may be used as a vacuum breaker or as a vent line for the steam generated when washing out the still. This line is opened and water is slowly run into the still. The still coil has a temperature in the neighborhood of 350 deg. F., so that the first of the wash water is quickly converted into steam. If water is run in too rapidly, this steam may have enough pressure to strain the joints of the still, thus causing leaks.

Water is fed to the still to a level about 4 in. in the gage glass. This water is boiled for a few minutes and dropped into the foots tank. The still is usually given a second wash and, if necessary, further washes. It is usually determined by analysis how much of the wash water should be saved if the foots is to be treated for glycerine recovery. It will be understood that washes may be so low in glycerine content that it would not pay to handle them for glycerine. The washes which are to be saved are run to the foots treatment department; the other washes are run to the sewer.

The treatment of glycerine foots for glycerine recovery will be discussed in more detail under that head.

CHEMICALLY PURE GLYCERINE (OPEN SYSTEM)

Where large quantities of chemically pure glycerine are manufactured, there are used separate distillation plants for the production of the dynamite and c.p. grades. Where only a small amount is produced, it is customary to use the same distillation unit for the production of both grades. In the latter case it is customary to accumulate a considerable quantity of the dynamite grade, which is later distilled to c.p. The reason for this is that the first of the c.p. glycerine distilled in a still used for dynamite has to be rejected due to the contamination of dynamite grade which deposits on the walls of the condensers.

The glycerine obtained in the air-cooled condensers from the distillation of soap lye crude will analyze about 75 to 90 per cent of glycerol. Depending on the quality of this distillate, it may be distilled for c.p. without further treatment, it may require bleaching or it may require acid and alkali treatment before the second distillation. When it is in proper condition for the second distillation, it is transferred to the still feed tank, where sufficient caustic soda is added to make it test slightly alkaline before being fed to the c.p. still.

The procedure in the distillation for c.p. glycerine is the same as that outlined for the dynamite grade. The

products obtained are c.p. glycerine foots, which are returned to the salt crude still to be distilled for the dynamite grade; c.p. sweet water, which is concentrated in an evaporator to c.p. sweet water crude, which is again distilled for c.p. glycerine (the residue remaining in the still becoming c.p. foots, to be returned to the dynamite glycerine plant), and air-cooled condenser stock. This stock is concentrated in a separate concentrator and run to the first bleaching tanks, where it is diluted with distilled water to give a 95 per cent glycerine.

The Closed System

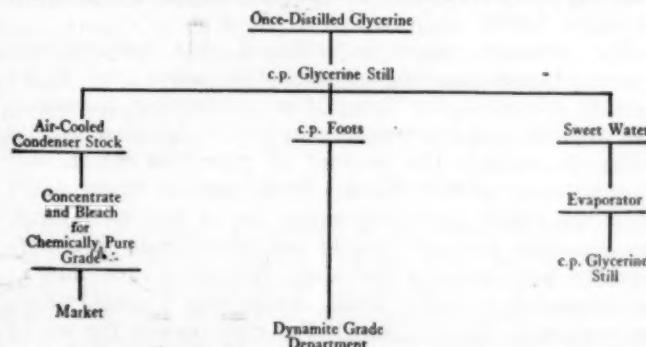
A glycerine distillation unit of the closed system type is shown in Fig. 2.

When starting the plant in operation, vacuum is first pulled on the whole unit. The still is charged with crude glycerine drawn in by vacuum to a level of about 10 in. on the straight side of the still or about 4 in. in the gage glass. When the vacuum reaches about 25 in., steam is turned on an extra heavy closed steam coil. This coil covers the bottom of the still and extends up the side close to the top of the still to prevent the condensation of vapors in the still. The valve on this steam line should be opened slowly to prevent any of the charge in the still from priming over. It should require about 10 minutes to open this valve full so that there is a pressure of 140 lb. or more on this coil. The condensation drain of the coil is connected to a trap so that full pressure may be maintained without loss of steam.

The sweet water evaporator is filled with water to a height of about 24 in. on the straight side. This evaporator is supplied with a heating coil for generating the steam to be injected into the still. A separate steam line may be run to the coil inlet, or else the drain from the still coil may be bypassed to connect to the evaporator coil inlet. The drain from the evaporator coil may be run to a trap.

After the vacuum on the still reaches about 25 in., steam is slowly turned onto the evaporator coil. The sweet water evaporator and the still are under practically the same vacuum when starting. As steam is generated in the evaporator, the vacuum on the evaporator drops; this steam is then drawn by the higher vacuum on the still into the still. The steam vapors pass from the evaporator through the preheater (which is designed as a surface condenser) and through a perforated pipe in the bottom of the still below the level of the crude glycerine.

The crude glycerine in the still has been heated to a temperature of about 350 deg. F. At this temperature the mixture of water vapors and glycerine is distilled



FLOW CHART FOR THE DISTILLATION OF ONCE-DISTILLED GLYCERINE TO CHEMICALLY PURE GRADE BY THE OPEN SYSTEM

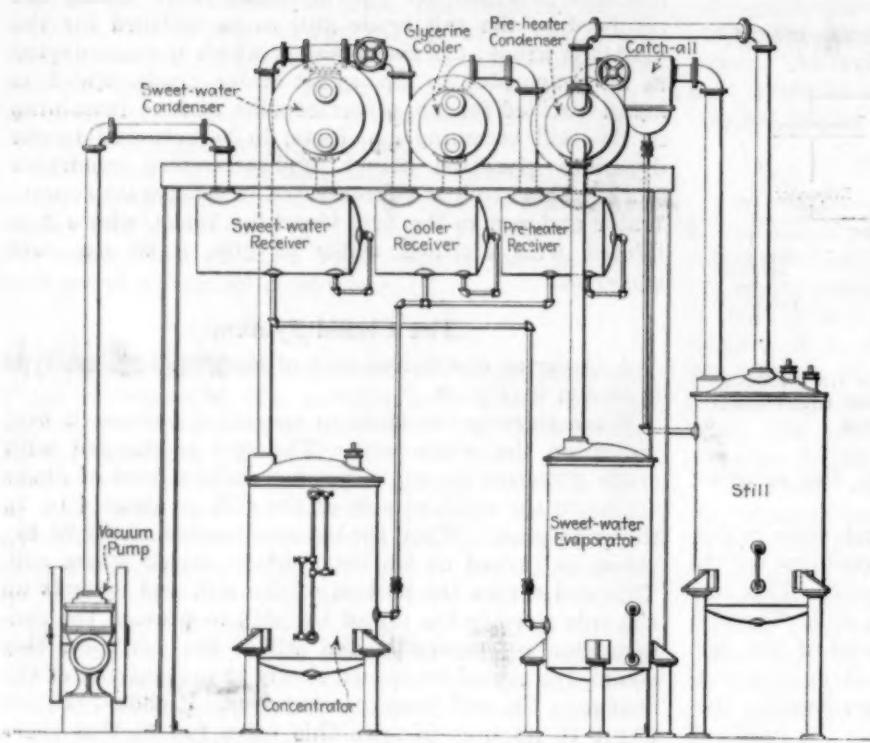


FIG. 2—A GLYCERINE DISTILLATION UNIT FOR THE CLOSED SYSTEM

off. The vapors pass from the still through a suitable catch-all, where entrained particles of crude glycerine are separated from the vapors and are returned to the still.

CONDENSING THE VAPORS

From the catch-all the vapors pass through the pre-heater, where they pass around the tubes, while the vapors from the sweet water evaporator pass through the tubes. The water vapors generated in the evaporator are in the form of steam under vacuum and so have a temperature of less than 212 deg. F. The mixture of water and glycerine vapors as they pass from the still have a temperature of about 325 deg. F. The vapors from the evaporator are thus preheated by the vapors from the still and are thus superheated before entering the still. The vapors from the still give up some of their heat in superheating the vapors from the evaporator and are thus condensed.

The glycerine vapors and the condensed glycerine pass from the preheater to the preheater receiver, where the vapors and glycerine are separated. The glycerine drops to the bottom of the receiver and runs by gravity to the glycerine concentrator, which is under vacuum. The vapors pass from the preheater receiver to the glycerine cooler.

The glycerine cooler is designed as a surface condenser, vapors passing around the tubes and water passing through the tubes for condensing purposes. The amount and temperature of water supplied to this cooler determines the amount of glycerine which will be condensed at this point. It is possible to condense all of the glycerine in the cooler, but if this were done, the glycerine probably would not concentrate to a sufficiently high gravity for the dynamite grade due to the presence of fatty acids, esters and glycols which are present in the distillate. For this reason, the water from the cooler is run at such a temperature that most of these impurities will pass beyond the cooler and be condensed with the sweet water.

The condensed glycerine, together with the remaining

glycerine vapors, passes to the cooler receiver, where the glycerine drops to the bottom of this receiver and runs by gravity to the concentrator. The vapors pass on to the sweet water condenser.

One of the chief advantages of the closed system of glycerine distillation is the fact that the amount of glycerine to be condensed ready for concentration is easily controlled. In regular practice from 90 to 95 per cent of the glycerine in the original crude glycerine can be recovered in the form of dynamite grade.

The sweet water condenser is a surface condenser wherein the vapors pass around the tubes and water passes through the tubes. All of the condensable vapors are here condensed to sweet water. The sweet water and non-condensable vapors pass into the sweet water receiver, where the sweet water drops to the bottom and runs by gravity to the sweet water evaporator, while the non-condensable gases pass off into the vacuum pump.

As distillation proceeds, more crude glycerine is fed to the still in order to maintain a practically constant level. The cycle of operation is continued until a sufficient amount of crude for a run has been fed to the still.

The amount of sweet water obtained during a run is the sum of the water used in starting operations, the water present in the original crude and the glycerine, fatty acids, esters and glycols which are condensed in the sweet water condenser. The amount of glycerine present in sweet water usually varies from 1 to 2 per cent of the glycerine fed to the still in the form of crude glycerine.

The concentrator is equipped with an extra heavy pipe coil which covers the bottom and passes part way up the straight side of this vessel. After the glycerine shows in the gage glass on the concentrator, high-pressure steam is turned on the coil slowly so that the dilute glycerine will concentrate to the dynamite grade while the process of distillation proceeds.

After a run has been completed, the concentrator, sweet water condenser and receiver are cut off from the remainder of the distillation unit by means of a valve and the vacuum pump pulls vacuum on this part of the unit only. The vapors from the concentrator pass to the sweet water condenser. The condensable vapors are collected in the sweet water receiver, while the non-condensable vapors pass to the vacuum pump. When the charge in the concentrator reaches a temperature in excess of 350 deg. F. under a vacuum within 1 in. of the barometer, it should be of dynamite grade. It is then transferred to the bleaching department, where a sample is taken and tested. If it is of dynamite grade, it is then bleached and drummed ready for the market. An average sample of each shipment of glycerine is analyzed before shipment.

When the charge in the concentrator is finished, the vacuum is broken and the charge transferred as above described. The concentrator is not regularly washed with water.

If the stock used for making the crude glycerine was of a low quality, if the lyes had been stored for a considerable time in unclean storage tanks or if for any other reason there is present any appreciable amount of glycols, it is impossible to obtain a glycerine of the gravity required for the dynamite grade. If glycols are present, it is necessary to handle the concentrator stock for their removal, as described later.

If it is desired to concentrate the sweet water to sweet water crude glycerine or to yellow distilled glycerine in the sweet water evaporator, this is done while running down to foots. The return line from the sweet water receiver to the evaporator is closed so that sweet water will accumulate in the sweet water receiver. After the sweet water in the evaporator has been concentrated, it may be redistilled for the dynamite grade or transferred to a suitable tank, where it is bleached and handled as described under "yellow distilled glycerine."

At the end of a run the vacuum breaker on the sweet water evaporator is opened so that vacuum on the still is broken through the perforated pipe on the bottom of the still. If the vacuum on the still is broken first, the foots may be drawn through the preheater into the sweet water evaporator. Any foots in the preheater would then be washed down by the glycerine condensed here during the following run and so contaminate it that a second distillation would be required to produce the dynamite grade.

The valve on the vapor line beyond the catch-all is closed so that no foots will splash into the preheater. The vacuum breaker on the still is next opened; the foots is dropped and the still washed as described under the preceding discussion of the open system.

BLEACHING OF DYNAMITE GLYCERINE

The dynamite glycerine as it comes from the concentrator has a color depending on the quality of the crude from which it was distilled as well as on the design of the distillation unit.

A bleaching medium such as bone black is usually employed. This is used for the double purpose of removing coloring matter and also to give a press cake so that fine particles of solid impurities will not pass through the press cloths.

The glycerine from the concentrator is transferred to a bleaching tank, which is equipped with an extra heavy closed steam coil for heating purposes and an open air coil for agitation. For each 1,000 lb. of dynamite glycerine there is usually added 1 lb. of bleaching material, after which the charge is agitated for a few minutes with air. Where c.p. glycerine is manufactured, it is customary to use the spent bleach from the c.p. department for bleaching.

After the bleach has been added and agitated for a few minutes, the circulating pump is started. This pump takes the glycerine with bleach from the bleaching tank and delivers it to the filter press, from where it is drained back into the bleaching tank. The air is then shut off and, when necessary, steam is turned on the closed coil to maintain a temperature slightly less than 170 deg. F. If the glycerine is permitted to become cool, it is difficult to filter, and if the temperature is permitted to exceed 170 deg. F., there is danger of precipitating coloring matter. The time required for bleaching may vary from 1 hour to a number of hours. If it does not bleach readily, more bleach is added from time to time.

The procedure of circulating the glycerine through the press is continued until the glycerine is satisfactory as to color and has a "shine," which is due to the removal of all solid impurities, including the bleach. When the charge is in satisfactory condition, it is drained from the press into the drumming tank, from where it is drawn off into suitable receptacles for shipment.

BLEACHING OF CHEMICALLY PURE GLYCERINE

The glycerine from the c.p. concentrator should be very light in color. The bleaching medium may be the same as that used for the dynamite grade, although a lower quality may be used for dynamite due to the less stringent specifications regarding the percentage of ash in an incinerated sample.

The glycerine from the c.p. concentrator is transferred to a bleaching tank which is equipped with an extra heavy closed steam coil for heating purposes and an open coil for air agitation. For each 1,000 lb. of glycerine in the tank there is added 1 lb. of bleach; it is well agitated for a few minutes and then filtered through a c.p. glycerine press. The filtrate is returned to the bleaching tank and the glycerine thus circulated through the press.

Samples are taken at frequent intervals, and if the bleaching is not proceeding satisfactorily, more bleach is added from time to time. If the temperature of the stock falls below 160 deg. F., steam is turned on the closed coil to maintain a temperature slightly less than 170 deg. F.

The glycerine as it comes from the concentrator has a glycerol content in excess of 95 per cent. Distilled water to reduce the content to this figure is usually added during bleaching so as to insure thorough mixture of the glycerine and water.

The operation of circulating the charge through the press is continued until the charge meets the specifications for c.p. glycerine. It is then run to drumming tanks, from where it is drawn off into suitable receptacles for shipment.

At times it happens that even under correct temperature and vacuum conditions it is impossible to concentrate to the gravity specified for the dynamite grade of glycerine. This is almost invariably due to the presence of glycols or, more especially, to the presence of trimethylene glycol, which is a fermentation product. There are two chief sources of glycol, one being low-grade stock and the other being the fermentation of spent soap lyes.

If glycol is present in the concentrated glycerine to an objectionable extent, it may be removed by distilling off a small fraction of the glycerine in the concentrator with high-pressure steam under highest vacuum. The glycol will distill more readily than glycerine, but carries glycerine off with it. By continued fractionation it is possible to produce a distillate which is high in glycol and low in glycerine.

YELLOW DISTILLED GLYCERINE

Yellow distilled glycerine is a distilled glycerine which is of lower specific gravity than the dynamite grade. It is usually made by concentrating the sweet water obtained in the distillation of crude glycerine for the production of the dynamite grade, but may be made by dilution of dynamite grade to a grade of a lower specific gravity.

There are no standard specifications for Y.D. glycerine.

erine such as are recognized for the dynamite and chemically pure grades, but it is sold on sample. It usually has about the same qualities as the dynamite grade except for the gravity, which is usually about 29 deg. Bé.

If made from sweet water, it is concentrated in an evaporator to the desired specific gravity and then bleached and clarified as described under bleaching of the dynamite grade.

TREATMENT OF GLYCERINE FOOTS FROM SALT CRUDE GLYCERINE

The residue left in the still at the end of a run is known as glycerine foots. This term is applied both to the residue as such and also to the mixture of residue and water which is obtained when washing out the still. The amount and quality of glycerine foots or foots obtained from any run will depend largely on the quality of the stock from which the salt crude glycerine was obtained, as well as on the efficiency of the lye treatment.

Foots consists of salt, glycerine, fatty acids, esters, polyglycerols and water. The amount of glycerine present will depend relatively on how far down the foots has been distilled. It is the practice in some factories to distill to dryness and then run the washings to the sewer; other factories drop foots in a semi-liquid state and then treat it for glycerine recovery.

The chief ingredients to be removed from the foots are the salt and fatty acids. Salt is easily removed by evaporating the solution to foots crude glycerine. However, if the fatty acids are not largely removed, this crude will distill very slowly and not much of the glycerine can be recovered. The main problem in foots treatment consists in the elimination of fatty acids.

The fatty acids present are those of the acetic series. A mineral acid will displace a fatty acid upon concentration; a mineral salt will combine with a fatty acid to form an insoluble mineral soap, qualitatively speaking. These conditions are usually made use of in the treatment of foots regardless of what varieties of treatment are given.

OUTLINE OF A COMPLETE METHOD OF TREATMENT

The following is an outline of a complete method of foots treatment which may be varied to meet special conditions in any given plant:

The foots as washed from the still is treated with a small amount of soda ash and then filtered through a press. This treatment precipitates some of the fatty acids as sodium soap, but is primarily used to clarify the foots by removing flocculent material which is present.

The solution is run from the filter press into lead lined tanks, where 60 deg. sulphuric acid is added. The amount of acid to be added is determined in the laboratory, where three samples of foots are treated with varying amounts of 60 deg. sulphuric acid in graduated glass vessels. Upon standing for a number of hours, there is a separation of tarry matter on the top and light material on the bottom. It is observed which of the three samples shows the best separation, and this is taken as the quantity to be added to the foots in the tank. The specified amount of 60 deg. acid is added to the tank and the charge is warmed by open steam and thoroughly agitated with air. After about 24 hours the tarry matter, which contains considerable fatty acids, is skimmed off and discarded.

After the tarry matter has been removed the strongly acid foots is transferred to a wood vat, where it is treated to a strong alkalinity with milk of lime, which precipitates some of the remaining fatty acids. This mixture is filtered to remove the lime and lime soap, the filtrate being run to a tank, where soda ash is added to remove the excess of lime. This lime precipitate

is removed in a press and the filtrate transferred to the spent soap lyes, to be again concentrated to salt crude glycerine. Where high grades of stock are used, such as in toilet soap factories, the foots may be thus returned for several years.

A simple and frequently employed method of treating foots is to transfer the foots from the still to a tank where sufficient sulphate of alumina is added to precipitate all fatty acids which can thus be removed. This solution is filtered into a second tub where sufficient acid is added to neutralize the ash alkalinity of the foots. This strong acid solution is then evaporated to foots crude glycerine.

Chicago, Ill.

The German Zinc Market

A pronounced shortage of zinc exists in Germany at present, says *Commerce Reports* of Oct. 9. Visible stocks are estimated at 8,000 metric tons, as compared with 14,000 metric tons a year ago.

The numerous factories using zinc in the Rhineland, Westphalia and other industrial centers of Germany are averse to consuming their small reserves and are endeavoring to cover their current needs by purchases in the open market. This is becoming increasingly difficult, due both to the scarcity of the metal and to the phenomenal upward movement of prices.

Numerous factors are responsible for the shortage of zinc in Germany. One of the most important was the loss of 80 per cent of the former Silesian zinc production to Poland. It was thought that this loss, which occurred in June, would not be felt immediately, since a free exchange of raw materials was provided for in the agreement covering the surrender of this territory, but transportation difficulties have prevented the arrival of expected shipments of zinc from Silesia. Constantly increasing acuteness of the coal situation and mounting prices of coal also hamper production.

Limited stocks in other countries make it seem unlikely that relief will come in the near future from abroad, even if German exchange should materially improve.

Carbide and Cyanamide Industry Slack in Norway

Norway has eight modern well-equipped calcium carbide plants, three of them built during the war, with a total annual output capacity of about 265,000 tons. These plants have installed about 170,000 hp. and in full operation employ about 3,000 men. Several of them are now completely closed down, and the others are operating with small or minimum force.

Commenting on this situation in a recent address, Ove Collet, a leading Norwegian electrochemical engineer, said that before the war the total world's production of calcium carbide was about 350,000 tons per year; that today Norway has factories with a capacity of nearly 80 per cent of the pre-war world production, and that war-time optimism as to the future of carbide has proved without sound basis, especially so far as the production of cyanamides is concerned.

The single cyanamide factory in Norway, that at Odda in the Bergen district, with its annual capacity of 75,000 tons, has been closed down for more than a year, and it is extremely doubtful whether it, or the carbide factory at the same place, which counted upon delivering a large part of its product for the manufacture of cyanamides, will ever again be in operation—certainly not unless new uses for both carbide and cyanamides can be found.

Overstrain, Internal Stresses and Creep

Effects Similar to Those Caused by Working Iron at Blue Heat Have Been Observed in Nickel and Certain Alloys—These Phenomena and the Results of Overstrain Are All Due to Rapid Acquisition of Increased Strength on Slip Planes

BY ZAY JEFFRIES AND R. S. ARCHER

WHEN hot-rolled iron or mild steel is tested in tension, it is found that the first part of the stress-strain diagram is a straight line, representing elastic deformation up to roughly one-half the tensile strength. If a bar of such material is loaded to a stress well beyond its yield point, it will be found on removal of the load to have lost its elasticity. On a second application of the load, the stress-strain diagram curves away from the straight line representing proportional deformation; the proportional (or elastic) limit has been reduced practically to zero. If after the first loading beyond the yield point (overstraining) the bar is permitted to rest for a few weeks before the second tensile test, it will then be found to have recovered its elasticity, and may have a new proportional limit higher than the original proportional limit of the hot-rolled material.

This recovery of elasticity takes place slowly at ordinary temperatures, but more rapidly as the temperature is raised. Muir found that the recovery of elasticity at 100 deg. C. is as complete after a few minutes as in 2 weeks at room temperature. At 250 deg. C. the time required is measured in seconds or fractions.

While the proportional limit in tension can be greatly increased (approximately doubled) by overstrain in tension followed by aging or heating at low temperatures, the limit in compression is not similarly increased. In fact, it has been stated that the gain in tensile proportional limit is almost exactly compensated by loss in compressive proportional limit, so that the total elastic range is not greatly changed. Van den Broek¹ has reported, however, that by stretching and reheating, the proportional limit of mild steel in tension can be about doubled, while still retaining approximately the original proportional limit in compression. In Fig. 1 the effects of aging and tempering are shown. Curve No. 118 shows the elastic properties of a hot-rolled low-carbon steel. Curves 114 and 171 show how the elastic limit in tension is reduced practically to zero by cold deformation either in tension or compression. The other curves illustrate the recovery of elasticity by aging and

by heating to 100 deg. C. The elastic limit in tension of the steel which was compressed and heated to 100 deg. C. has not quite been restored to its original value, but it is possible it would upon further heating.

Recovery of elasticity on aging at ordinary temperatures or on heating at temperatures up to about 300 deg. C. is accompanied by increase in hardness and tensile strength and by loss of plasticity. Elongation is usually reduced to a marked extent, although the reduction of area is less affected. The change that takes place is therefore a general hardening and stiffening.

BLUE HEAT PHENOMENA IN IRON

It has long been known that iron is peculiarly brittle at temperatures from 200 to 400 deg. C., and that deformation, such as bending, effected at these temperatures causes the metal to be much more brittle after cooling to room temperature than would a similar amount of deformation at room temperature. Because of the blue scale or temper color formed on iron and steel, this temperature range is commonly called a "blue heat," and the brittleness is called "blue brittleness."

Tensile tests at elevated temperatures show that iron actually has a higher tensile strength but lower elongation and reduction of area in the blue heat range than at room temperature. The curves in Fig. 2 show the results of tests at the U. S. Bureau of Standards² on a mild steel whose properties are essentially those of iron. Results of a similar nature have been reported by one of the authors,³ and are reproduced in Fig. 3. Robin has shown that the Brinell hardness is also greater at a blue heat than at room temperature.

The fact that a given amount of deformation effected at a blue heat hardens iron to a greater extent than does the same amount of deformation effected at room temperature is illustrated nicely by some experiments on the drawing of Armco iron wires. For example, wires reduced cold from 0.042 in. to 0.025 in. (64 per cent) at room temperature and at 275 deg. C., had the following tensile properties (measured at room temperature):

Temperature of Drawing	Tensile Strength Lb. per Sq. In.	Elongation Per Cent	Reduction of Area Per Cent
Room temperature.	85,720	2.60	70.0
275 deg. C.	111,000	1.58	67.0

The wire drawn at blue heat is stronger and less plastic than that drawn at room temperature.

About 30 years ago Le Chatelier⁴ observed that the tensile properties of iron in the blue heat range are greatly affected by the rate of application of load. One specimen, for example, had a tensile strength of 66,850 lb. per sq.in. and an elongation of 10 per cent when broken in 20 minutes at a temperature of 170 deg. C.

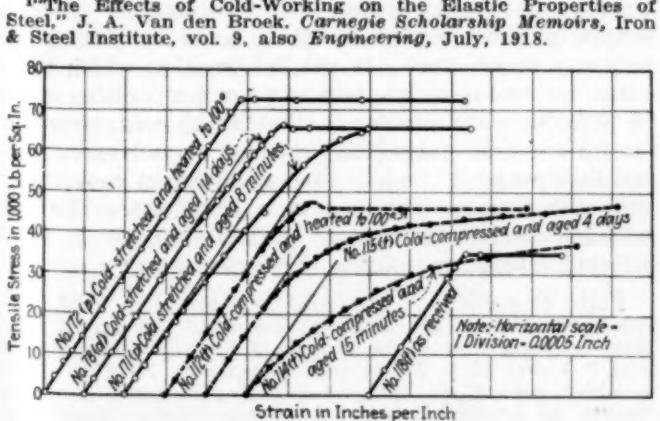


FIG. 1—EFFECT OF AGING AND TEMPERING ON THE ELASTIC PROPERTIES OF COLD-WORKED MILD STEEL. (VAN DEN BROEK)

¹"The Effects of Cold-Working on the Elastic Properties of Steel," J. A. Van den Broek, *Carnegie Scholarship Memoirs*, Iron & Steel Institute, vol. 9, also *Engineering*, July, 1918.

²"Strength and Elasticity of Boiler Plate at Elevated Temperatures," H. J. French, *Chem. & Met. Eng.*, vol. 26, p. 1207.

³"Effect of Temperature, Deformation and Grain Size on the Mechanical Properties of Metals," Zay Jeffries, *Trans., A.I.M.E.*, vol. 60, p. 474.

⁴Abstracted in "The Blue Brittleness and Aging of Iron," Fettweiss, *Stahl und Eisen*, Jan. 2 and Jan. 9, 1919.

On increasing the rate of pulling until fracture occurred in 2 seconds, the tensile strength fell to 38,400 lb. per sq.in., while the elongation rose to 28 per cent. The general result of his researches follows:

With various rates of applying load, the curves which give the tensile properties of iron as functions of temperature are approximately the same shape, but when testing at higher speeds, the curves are shifted toward higher temperatures. In other words, the maximum in strength and hardness does not occur at a fixed temperature, but at a temperature which depends on the rate of loading and is higher as that rate increases.

To explain these phenomena, Le Chatelier postulated that at temperatures above about 80 deg. C. any permanent deformation of iron gives rise to an irreversible transformation which tends to raise the tensile strength and decrease the ductility. This transformation requires a certain amount of time for its complete development, but takes place more quickly the higher the temperature. Above 300 deg. C., however, the transformation is less effective in producing strength and hardness, because of incipient annealing.

In a paper published in January, 1919, by Fettweis,⁴ this transformation of Le Chatelier is, apparently for the first time, identified with the transformation responsible for elastic recovery after overstrain. Fettweis did not propose any hypothesis as to the mechanism of this transformation.

In February, 1920, one of the present authors⁵ inde-

⁴Discussion by R. S. Archer, on paper "Physical Changes in Iron and Steel Below the Thermal Critical Range," Zay Jeffries, February, 1920, meeting A.I.M.E.

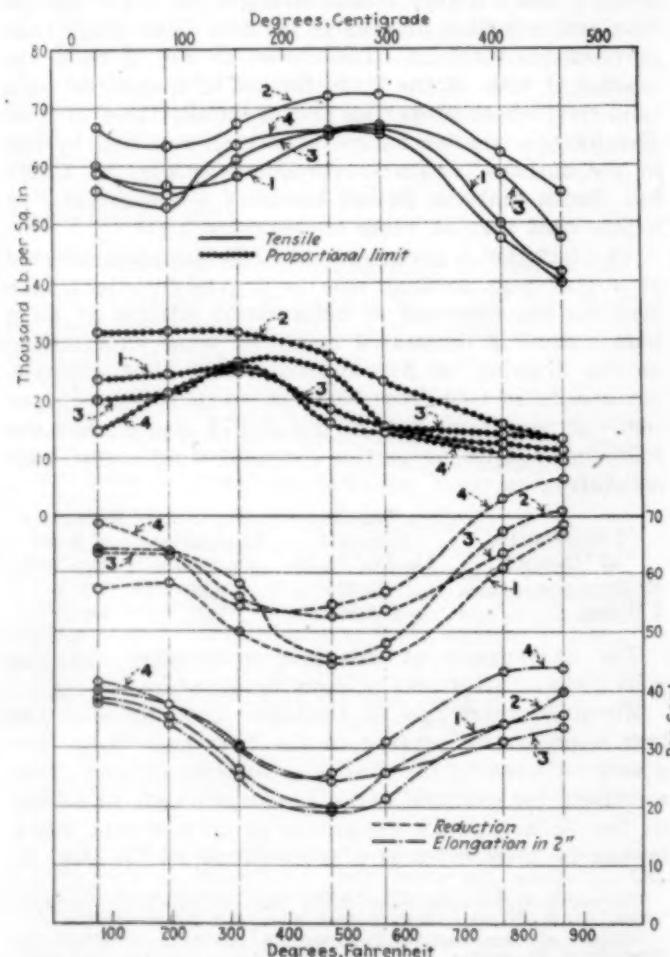


FIG. 2—EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF MILD STEEL. (FRENCH)

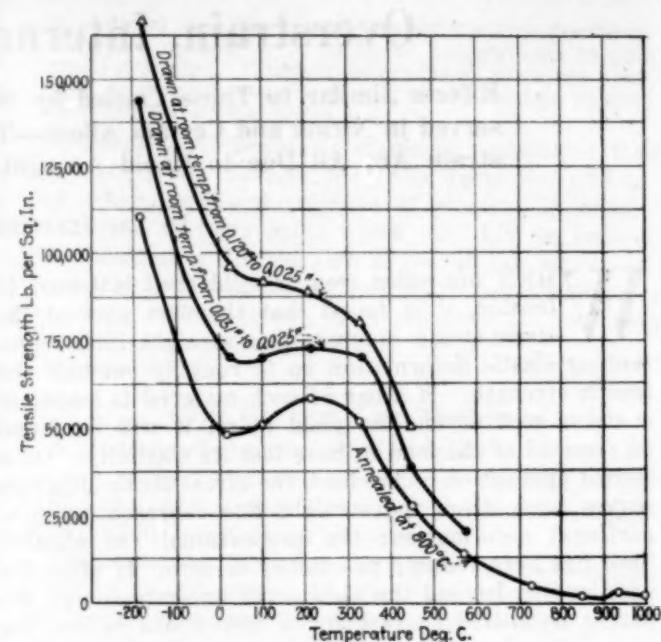


FIG. 3—TENSILE STRENGTH OF ANNEALED AND COLD-DRAWN ARMCO IRON WIRES AT VARIOUS TEMPERATURES. (JEFFRIES)

pendently stated the theory that the blue heat phenomena and elastic recovery are due to the same cause: A spontaneous increase in resistance to motion on the slip planes formed during deformation.

It is supposed that immediately after motion begins on a slip plane the resistance is less than the shearing strength of the unbroken crystals. Deformation tends to progress by continued motion on this plane, until brought to a halt by end resistance—that is, by the interference of adjacent grains. If the deforming load is removed immediately after slip has started and time is allowed for elastic recovery, then the resistance to motion on the plane of slip spontaneously increases to a value equal to or greater than the resistance to the formation of a new slip plane. Further deformation must then take place on new planes. The time required for this increase in resistance is less as the temperature rises, so that at about 250 to 300 deg. C. the change is practically instantaneous and occurs during the progress of any ordinary deformation such as a tensile test. The result is that at a blue heat a given *external* deformation produces more internal deformation, or cold-working, and hence more *hardening*, than the same amount of external deformation effected at room temperature.

This statement applies to deformations effected within a short period of time, such as during an ordinary tensile test. If the deformation which takes place during the tensile test at room temperature could be effected very slowly so that there was time for elastic recovery during the test, we should expect the tensile strength to be increased to an extent comparable with the increase obtained at a blue heat. The following experiments made by J. T. Bottomley⁶ in Lord Kelvin's laboratory confirm this expectation:

Eight pieces of soft iron wire were tested in tension by gradually increasing stress applied in 10 minutes of time in each case. They broke at loads of 43.5 to 46 lb. (average 45.2 lb.) with 17 to 22 per cent elongation. Another specimen left with 43 lb. hanging on it for 24 hours and then broken by gradual increase of stress during 25 minutes broke at a load of 49.25 lb. with 15 per cent elongation.

⁶"The Testing of Materials of Construction," Unwin, 3rd ed., p. 113.

Another left for 3 days with 43 lb. hanging on it and then broken by increasing stress bore 51.5 lb. and elongated 14.4 per cent. A wire loaded first with 40 lb. and broken with gradual addition of load in 2 months broke at 57.25 lb. The slower loading had therefore increased the strength by about 27 per cent, which is an increase of the same order of magnitude as that obtained by testing in the blue heat range with ordinary rates of applying load.

According to the theory here described, the blue heat properties of iron are due to certain peculiarities of the process of deformation, and are not specific properties of crystalline iron. The yield point, tensile strength, Brinell hardness, elongation and reduction of area are all properties whose measurement necessarily involves plastic deformation. The true elastic limit, on the other hand, being the stress at which plastic deformation begins, cannot be affected by the mechanism described, nor can the modulus of elasticity. Unless there is an allotropic change (change in atomic arrangement), it is to be expected that both elastic limit and elastic modulus will decrease continuously as the temperature rises.

There is a lack of sustaining evidence of any allotropic change in these temperature regions, and recently E. C. Bain has found by X-ray analysis that iron at 300 deg. C. has the same body-centered cubic lattice as at room temperature.

TABLE I—STRENGTHENING OF NICKEL WIRE AT 250 TO 275 DEG. C.

Treatment of Specimens	Tensile Strength, Lb. Per Sq. In.	Per Cent Increase
Kept in liquid air until tested, 15 min. after drawing.	125,000	.....
Kept in liquid air until tested, 15 min. after drawing.	126,000	.....
Kept in liquid air until tested, 15 min. after drawing.	126,000	.....
Kept in liquid air until tested, 15 min. after drawing.	126,000	.....
Average.....	125,750	.....
Heated at 275 deg. C. 2 min.....	130,500	3.1
Heated at 275 deg. C. 5 min.....	132,000	4.6
Heated at 275 deg. C. 10 min.....	130,000	.....
Heated at 275 deg. C. 30 min.....	131,000	.....
Kept in liquid air until tested, 45 min. after drawing.	126,000	.....
Heated at 250 deg. C. 1 min.....	128,000	1.6
Heated at 250 deg. C. 2 min.....	128,000	1.6
Heated at 250 deg. C. 5 min.....	128,000	1.6
Heated at 250 deg. C. 20 min.....	130,000	3.2
Kept in liquid air until tested, 2 hr. after drawing.....	125,000	.....
Heated at 250 deg. C. 5 min.....	128,000	2.45
Heated at 250 deg. C. 15 min.....	130,500	4.00
Heated at 250 deg. C. 3 hr.....	127,000	.....

Actual determinations of elastic limit by various investigators are not in good agreement. Howard¹ in 1890 reported that the elastic limit decreases with rise in temperature. Huntington² also gave a curve which does not pass through any maximum in the blue heat range. Martens,³ however, reported that the elastic limit passes through a maximum at about 200 deg. C., and recently H. J. French⁴ found a maximum value at 200 deg. C. about 14 per cent greater than at room temperature. Accurate determination of proportional or elastic limit at the higher temperatures is a matter of some experimental difficulty, and in fact the values found in any determination depend on the sensitivity of the instruments. From the sufficiency of the deformation theory in explaining the other blue heat properties and the evidence against an allotropic change, it is very probable that the "elastic limit" which increases in the blue heat range involves some plastic deformation and that more sensitive measurements would show a continuous decrease in elastic limit and elastic modulus. The rise in tensile strength at a blue heat is most

pronounced for iron in the annealed condition. Such strengthening becomes less in cold-worked irons tested at a blue heat, and finally in iron severely cold-worked and aged for some time, the tensile strength at room temperature is greater than at any higher temperature. This simply means that, because of the great hardening already obtained by cold-working and aging, the hardening effect of the relatively small deformation occurring during the tensile test is not sufficient to compensate for the natural loss of cohesion due to the rise in temperature. Furthermore, heating to temperatures as low as 100 deg. C. produces a slight softening in iron which has been severely cold-worked and aged.

OVERSTRAIN IN NON-FERROUS METALS

Iron appears to be unique in the magnitude of the overstrain and blue heat phenomena, but similar properties have been observed in some other metals.

It has been found that the tensile strength vs. temperature curve for nickel exhibits a horizontal portion between 200 and 300 deg. C., although the tensile strength does not actually rise in this region. There is a corresponding drop in elongation and reduction of area. This has been attributed to the allotropic change in nickel supposed to correspond to the magnetic change at 320 deg., but recently the space lattice of nickel at 500 deg. has been determined by E. C. Bain and found to be the same as at room temperature. The magnetic change is therefore not due to allotropy (in the sense of atomic rearrangement). In view of the properties of iron, it seemed probable that the break in the tensile strength-temperature curve of nickel was due to the same sort of spontaneous hardening.

W. P. Sykes has recently made some tests which show that freshly cold-drawn nickel wires are hardened by heating at 250 and 275 deg. C. His results are given in Table I. The nickel wire was drawn cold from 0.090 in. to 0.025 in. diameter. This wire was immersed in liquid air immediately after coming through the finishing die and kept in liquid air until tested or put in an electric muffle furnace for heat-treatment as designated in the table. Immersion in liquid air was for the purpose of preventing the hardening process from taking place, as it is known that in iron the change is extremely slow at low temperatures.

Price and Davidson⁵ have also reported a hardening effect on heating cold-rolled nickel at temperatures up to 450 deg. C. Brinell hardness of bars cold rolled from 0.5 in. to 0.134 in. was as follows:

As rolled.....	235
Heated to 250 deg. C.....	262
Heated to 350 deg. C.....	255
Heated to 450 deg. C.....	248
Heated to 550 deg. C.....	228

The heating time was $\frac{1}{2}$ hour to reach temperature plus 25 minutes at heat in all cases. A maximum strengthening effect was found in longitudinal specimens after heating at 250 deg. C., the strength increasing from about 123,000 lb. per sq.in. to 134,000.

It has been reported that the first effect of annealing cold-worked copper and aluminum at low temperatures is to increase the strength or hardness, but these observations are not well established.

It is well known that the first effect of annealing cold-worked brass is a slight hardening. Bengough and Hudson, working with a 70:30 brass, found that the tensile strength increased in all cases with rise in

¹"Physical Properties of Iron and Steel at Higher Temperatures," J. E. Howard, *Iron Age* (1890), vol. 45, p. 585.

²"Effect of Temperature on Tensile Tests of Copper and Its Alloys," A. K. Huntington, *J. Inst. Metals* (1912), vol. 8, p. 126.

³"Influence of Heat on the Strength of Iron," Martens, *Proc. Inst. Civil Engrs.* (1890-91), vol. 104, p. 209.

⁴Discussion on "Physical Properties of Nickel," by Browne and Thompson, *Trans. A.I.M.E.*, vol. 64, p. 414.

annealing temperature up to about 300 deg. C. The yield point remained practically constant up to 100 deg. or higher, after which it dropped off. The effect of rest and low-temperature annealing on the elastic limit was investigated in one case, and it was found that the elastic limit was not affected by aging for 12 days at ordinary temperatures or by heating for 1 hour at 90 deg. C. The yield point was raised by both of these treatments. Annealing 1 hour at 210 deg. C. considerably decreased both elastic limit and yield point.

Bassett and Davis,¹¹ in their careful work on the relation of grain size to Brinell hardness in cartridge brass, found that annealing at low temperatures increased the Brinell hardness of the cold-worked metal, the increase being more marked the greater the reduction by rolling. This is shown in Fig. 4.

The increase of tensile strength reported by Bengough and Hudson has been confirmed by Mathewson and Phillips.¹² Their material was a very pure 70:30 brass which had been reduced cold 40 per cent. In this condition the average properties (five tests) were:

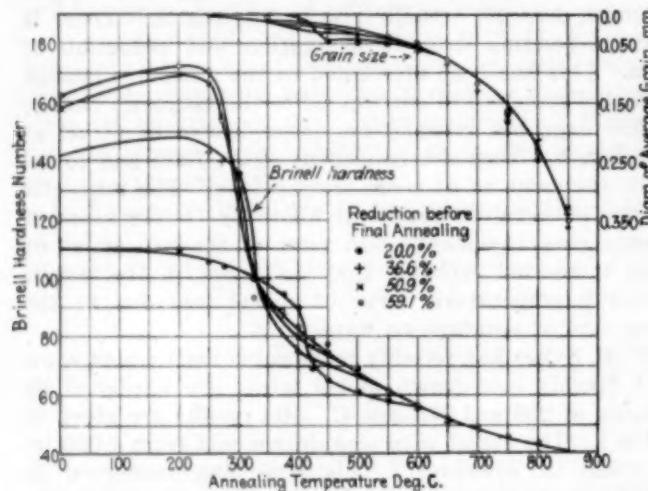


FIG. 4—EFFECT OF ANNEALING ON BRINELL HARDNESS OF COLD-WORKED BRASS. (BASSETT AND DAVIS)

tensile strength 76,763 lb. per sq.in., elongation 11.1 per cent and scleroscope hardness 33.2. After heating for $\frac{1}{2}$ hour at 200 deg. C. the tensile strength (average of five tests) was 78,512, elongation 10.0 and hardness 34.2. Annealing at 300 deg. C. caused appreciable softening and visible recrystallization.

In connection with their investigation of season-cracking in brass, Moore and Beckinsale¹³ have determined the effect of heating for 1 hour at temperatures from 250 to 325 deg. C. on the elastic limit. Their curves are reproduced in Fig. 5. It will be observed that the treatment at 250 deg. C. practically doubled the proportional limit. Treatments at higher temperatures have in all cases left the metal in an elastic condition, although the proportional limit decreases as the temperature of treatment is raised.

Hardening effects have been observed in nickel silver. F. C. Thompson found that the Brinell hardness was increased from 130 to 143 by annealing $\frac{1}{2}$ hour at 300 deg. C. Price and Davidson¹⁴ have also reported an

¹¹"A Comparison of Grain-Size Measurements," Bassett and Davis, *Trans. A.I.M.E.*, 1919, p. 428.

¹²"Recrystallization of Cold-Worked Alpha Brass on Annealing," Mathewson and Phillips, *Trans. A.I.M.E.*, vol. 54 (1916), p. 611.

¹³"The Prevention of Season-Cracking in Brass by the Removal of Internal Stress," H. Moore and S. Beckinsale, *Trans., Faraday Soc.*, vol. 17, 1921, p. 162.

¹⁴"Physical Tests on Sheet Nickel Silver," Price and Davidson, *Trans. A.I.M.E.*, vol. 64, pp. 510-523.

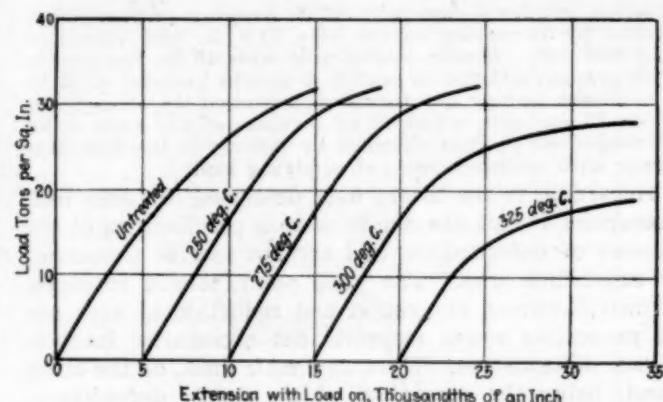


FIG. 5—EFFECT OF HEATING AT LOW TEMPERATURES ON ELASTIC PROPERTIES OF COLD-WORKED BRASS. (MOORE AND BECKINSALE)

increase in both yield point and tensile strength on annealing cold-worked nickel silver at 350 deg. C.

On the basis of the theory given above for the blue heat properties of iron it might be expected that brass and nickel silver would show discontinuities in hardness and strength when tested slightly above room temperature. Unfortunately, most of the work on the properties of these alloys at higher temperatures has not included tests between 20 and 200 deg. C.

The evidence on the occurrence of overstrain and blue heat phenomena in metals other than iron is thus rather limited. There is a strong indication that the phenomena are of general occurrence, although they are certainly most prominent in iron. It may or may not be of some significance that both iron and nickel are magnetic and that the extent to which spontaneous hardening is manifested is greater in the more magnetic element.

INTERNAL STRESSES AND CREEP

When a bar of iron is unloaded after being strained beyond its yield point, it does not return immediately, but approaches a stable position with increasing slowness. A more familiar example of the same phenomenon is found in the behavior of iron or steel when it is attempted to bend a piece to some desired shape, as in "straightening" a forging. It is at once apparent that in order to make the piece assume a final desired position it is necessary to bend it *past* this position, as there is an immediate elastic spring toward the original shape. Having caused the piece to assume the desired shape, it may be found some days later that it has returned still further toward its original shape. This slow return is often called "creep."

Creep is due to the action of internal stresses, produced by the deformation, slowly moving the crystalline fragments back along the slip planes toward their original positions. As has been remarked before, the elastic limit of a piece of metal is not passed until stresses are set up in some of the grains exceeding their shearing strength along the planes of easy slip. By the time the yield point is reached, practically all of the crystalline metal is highly stressed. When the load is removed, these elastic stresses are to a large extent relieved, but some remain to be gradually lessened by the slow movement of the grain fragments along the slip planes. Freshly formed slip planes have a relatively low resistance to motion. After elastic recovery is complete, little or no creep is to be expected. As a practical example, steel forgings are often

straightened at or above a blue heat, so as to "stay put." The internal stresses set up by overstraining are never completely relieved unless the metal is in a semi-plastic condition in which its elastic limit is substantially zero. That is, internal stresses are relieved only by flow, and their relief is opposed by elasticity. Metals and alloys which are elastic at ordinary temperatures are left in a state of internal stress (also spoken of as "internal strain") by all commercial cold-working processes. High internal stresses can also be produced by uneven temperature changes. Rapid cooling, uneven sections and mass contribute to such stresses.

The algebraic sum of the internal stresses in a piece of metal must always be zero; that is to say, tensile stresses in one portion are balanced by compressive stresses in other portions. An analogy may be drawn to the various members of a steel bridge, which may each be stressed in a different way, in tension, in compression, under bending, or under combinations of such stresses, although the entire structure is in a state of equilibrium as regards external forces. Now if a bridge member in tension is cut in two, its ends spring apart, and the sound members rearrange their loadings as best they can; on the other hand, if a compression member is cut, the ends come together. Internal stresses in a piece of metal can be detected and measured by means of the same principle.

If a light cut is machined from the surface of a piece of cold-drawn rod whose length has been carefully measured, a second measurement will show that the length of the remaining bar has increased. This means that initially the external layers of the rod were in a state of tension while the core was in compression. On removing some of the exterior metal, which was holding the core in compression, the compressive stress in the core is partly released and it automatically increases in length a corresponding amount. The average stress intensity in the layer of metal which has been removed can be calculated from the observed change in length of the remainder of the rod: the relative change in length times the modulus of elasticity gives the stress which has been released; this stress multiplied by the area of the section gives the total force released, which is exactly equal to the tensile force in the metal machined off. This force divided by the cross-section area of the metal machined off gives the average stress intensity in that metal.

The dimensional changes which result from cutting away part of an internally stressed piece of metal are often a source of considerable trouble. A surface originally machined "true" may be thrown out of true on removing stressed metal from some other portion of the piece.

If the external load to which a metal is subjected in service happens to be added to internal stresses already present in the piece, the total stress may exceed the strength of the material and failure may result at an external load far below that which would normally cause failure. Under some exceptional circumstances, it is possible to utilize internal stresses to oppose external loads and thus extend the useful strength of the metal. Ordinarily, however, internal stresses are considered to be a source of weakness.

Metals sometimes fail spontaneously from internal stresses. The most common examples are hardened steel and cold-worked brass. Severe stresses are set up in steel by the hardening operation, both by uneven temperature changes in themselves and by the volume

changes incident to hardening. Such induced stresses are often sufficient to burst the steel, either during the hardening or some time thereafter.

REMOVAL OF INTERNAL STRESS IN BRASS

Cold-worked articles of brass, such as cold-drawn bars, cartridge cases or spun jars or cups, often split open spontaneously. The failure may occur months or years after fabrication, and is known as "season cracking." It is due to internal stresses induced by cold-working, assisted usually by corrosive action. Season-cracking can be prevented by so controlling the deforming operations as to avoid setting up excessive internal stresses or by reducing the internal stresses to a safe value by annealing. It was shown by Merica¹⁵ that the internal stresses in brass can be reduced below the danger point by annealing at temperatures too low to produce visible recrystallization or appreciable softening. More recently a very interesting quantitative study of the removal of stresses in brass by low-temperature annealing has been reported by Moore and Beckinsale.¹⁶ Their results are summarized as follows:

"1. The rate of reduction of stress is fairly rapid at 200 deg. C. at first, but becomes very slow when the stress has been reduced to one-half to one-third its initial value and important stresses remain even after treatment for 24 hours or longer.

"2. As the temperature is raised the rate of reduction of stress increases, but shows the same characteristic of slowing down as the stress falls. At 300 deg. C. a very much shorter time is required to reduce the stress to a given figure than at 200 deg. C. and the remaining stress is much lower after a given time at the higher temperature, in brass of the same hardness.

"3. The higher the initial stress the higher is the remaining stress after a given treatment, in brass of the same hardness, although the amount of stress removed is greater the higher the initial stress.

"4. The higher the hardness of the brass the lower is the remaining stress after a given treatment and for a given initial stress. In other words, the harder the brass the more rapidly is a given initial stress reduced at a given temperature.

"5. A large reduction in the amount of stress is brought about by annealing conditions (temperature and time) which raise the hardness of cold-worked 70:30 brass, but treatments which result in some reduction of hardness are necessary to bring about complete removal of stress.

"6. At temperatures in the range 200 to 300 deg. C. slight plastic flow occurs in cold-worked brass at low stresses. The amount of flow is greater as the temperature is higher, the stress greater and the time longer for which the stress is maintained.

"7. The reduction of internal stress by low-temperature annealing is dependent on the plastic flow mentioned in (6).

"8. This plastic flow involves a lowering of the elastic limit at the temperature at which it occurs. This reduction of elastic limit is, however, not permanent provided the treatment is applied for a time not exceeding 1 hour at 275 deg. C. or certain limiting times which are much longer at lower temperatures. The limit of proportionality and elastic limit are raised considerably by treatments which do not exceed these limits of temperature and time."

These results are true specifically only for a 70:30 brass, but some general conclusions are warranted regarding the removal of internal stresses from other metals induced by cold-work or temperature changes. The temperatures at which stresses are removed from brass are near the lowest temperature of recrystallization. Complete removal of stress required an annealing which produced some softening and hence some recrystallization. It is probable that any metal must be heated to a temperature near its recrystallization temperature to remove stresses; heating to higher temperatures will result in more complete removal.

¹⁵"The Failure of Structural Brasses," P. D. Merica and R. W. Woodward, *Trans., Am. Inst. Metals*, vol. 9 (1915), p. 298.

Manufacture of Carbon Bisulphide*

BY GEORGE A. RICHTER

Research Department, Brown Co., Berlin, N. H.

IN THE past 20 years there have appeared from time to time in various technical journals articles describing in some detail the manufacture of carbon bisulphide in the electric furnace. Most of the articles in recent years have referred specifically to the so-called Taylor process. By using production data and power-consumption figures given by Mr. Taylor, others have calculated the approximate thermal efficiency of the operation. Such estimates are based upon the thermal constants to be found in the literature, and indicate a thermal efficiency ranging from 35 to 55 per cent, according to the assumptions made.

It has been thought of sufficient interest to go into the study somewhat further, with a hope of striking a thermal balance in order to approximate at least the distribution of heat losses in the manufacture of carbon bisulphide.

Inasmuch as the writer has had no personal experience with the Taylor method of making carbon bisulphide, it will be necessary to make such calculations from data obtained from a manufacturing process which differs in some essentials from the better-known Taylor process. In order to avoid a misunderstanding, it will be advisable (1) to review the general principles involved in the production of bisulphide of carbon, (2) to describe briefly, but specifically, the process under consideration, and (3) to give some data and calculations covering the process.

GENERAL PRINCIPLES OF MANUFACTURE

Large-scale production of carbon bisulphide is based upon a direct union of two elementary substances, carbon and sulphur, such a union taking place from 600 to 1,000 deg. C. At these reaction temperatures the sulphur is obviously present as a vapor and the unreacted carbon exists as an incandescent solid. Care must be used in selecting the type of carbon for successful operation. In the writer's experience, gas coke, anthracite coal and other forms of dense carbon have proved of little use. Best results are possible with a reasonably good grade of willow or birch charcoal, which has a low ash content.

It is important that both sulphur and carbon employed be as dry as practicable. Water brought into the furnace as moisture in the sulphur reacts with the sulphur in the high-temperature zone, forming hydrogen sulphide and other volatile sulphur compounds. These side reactions evidently convert sulphur into useless products at the expense of some heat.

Water present in the charcoal delivered to the furnace is usually distilled from the furnace at a temperature lower than that needed for reaction with sulphur. This is due to the fact that charcoal is usually introduced into the furnace at the upper low-temperature zone in order to conserve heat by employment of countercurrent principles. This calcination of charcoal results in a certain small loss of heat, as will be discussed later. It is also of importance to specify a well-burned charcoal. A poorly burned product contains substantial amounts of hydrocarbons which cause loss of both heat and sulphur, due to the formation of useless sulphurated compounds, which distill off with the carbon

bisulphide. In practice it has been found profitable at times actually to dry and reburn some of the charcoal purchased before putting such charcoal into the furnace.

DESCRIPTION OF PROCESS

Fig. 1 shows diagrammatically the general layout of the installation under discussion. The furnace consists of a cast-iron shell lined with a suitable grade of refractory. Provision is made for water-cooled electrodes, through which power is furnished from a two-phase 440-volt a.c. line. Transformers and switchboard allow voltage changes in 10-volt steps, such changes being made either to control production or to adjust total power input as the internal electrical resistance of the heating bed varies from time to time.

A resistance bed of broken arc-light carbon is distributed over the entire cylindrical space between the electrodes. The heat generated is conveyed from the incandescent bed of resistor carbon to the charcoal above.

Sulphur is fed into the furnace from a melting kettle. It is fed through a liquid seal and delivered near the center of the hot zone, where it is vaporized instantly and reacts with the hot charcoal present.

Charcoal is introduced periodically as needed by means of a suitable hopper through the top of the furnace shell. Carbon bisulphide, hydrogen sulphide and other sulphur compounds leave the furnace and enter a condenser, where the bisulphide is recovered, and the impurities are washed out continually by means of overflow water.

Attempts have been made to control the temperature of the furnace by means of pyrometers. Peep holes, however, have proved fully as satisfactory, and represent considerably less maintenance costs. The usual maximum temperature is about 1,000 deg. C.

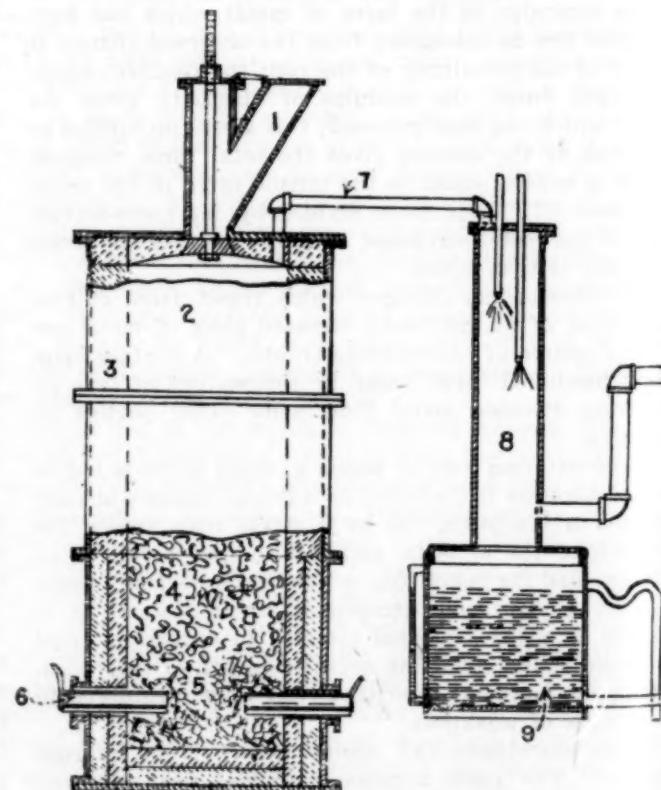


FIG. 1—CARBON BISULPHIDE PROCESS

1. Charcoal hopper; 2. Furnace; 3. Refractory lining; 4. Charcoal; 5. Resistance carbon; 6. Electrode; 7. Delivery pipe; 8. Condenser; 9. Product.

*Paper presented at the forty-second general meeting of the American Electrochemical Society in Montreal, Sept. 21, 22 and 23, 1922.

The unit diagrammed above will produce 1 ton of carbon bisulphide in 24 hours with a power consumption of 0.5 to 0.7 kw.-hr. per pound of washed material recovered. The principal losses of electrical heat and chemicals may be listed as follows:

1. Radiation of heat from a surface of furnace, including electrode losses.
2. Loss of sensible heat in exit vapors.
3. Loss of heat due to melting and vaporization of sulphur which leaves the furnace as unreacted sulphur and worthless sulphur compounds.
4. Loss of chemical accompanying heat loss listed under 3.
5. Loss of carbon bisulphide due to leaks and solution in wash water.

CALCULATING DISTRIBUTION OF HEAT LOSSES

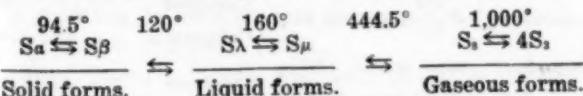
In calculating distribution of heat losses, it is important to have available values for the chemical losses which represent heat consumption without the equivalent yield of product. It is fair to estimate a sulphur loss represented by items 4 and 5 as totaling 20 per cent of the original sulphur fed to the furnace. This is equivalent to an 80 per cent yield of washed carbon bisulphide, based on original sulphur used, and must be accompanied by an additional 20 per cent power consumption over that theoretically required for the production of carbon bisulphide actually recovered.

Knowing the radiating surface, average shell temperature and the recovery of carbon bisulphide per 24 hours, it is possible by making a reasonable assumption for the heat conductivity coefficient to estimate the heat loss due to radiation. Operating conditions at the plant considered warrant accepting as reasonable the value $K = 2$.

In order to calculate thermal efficiency, it is necessary to know the theoretical number of heat units needed for the formation of a unit weight of carbon bisulphide. It is also essential that we know the heat requirements for each of the steps of the reaction in question. This involves tabulation of data on latent heats, specific heats and heat of formation. Unfortunately, there are some discrepancies in physical constants reported, and it has been deemed advisable to record the values found in standard compilations. Such values are given in detail in the appendix. As far as the writer was able to ascertain, no direct measurements of specific heat of sulphur vapor has ever been made. There appears to be an agreement in values given for heat of formation of carbon bisulphide, starting with solid sulphur and carbon and finishing with gaseous carbon bisulphide. Koref has calculated from equilibria data the heat of formation of carbon bisulphide, starting with sulphur vapor, and has shown that such a reaction is exothermic rather than endothermic, as is the case when solid sulphur is used. The vaporization of the sulphur prior to its reaction with carbon demands enough heat to cause a change from an exothermic to an endothermic process.

HEAT OF FORMATION

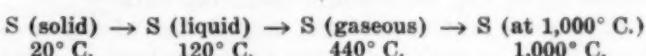
Mellor gives the following conception of the equilibria involved in raising sulphur to 1,000 deg. C. This summarizes in qualitative manner the results of the investigations of Smith and others during the past 30 years.



It is evident from this that the thermal data required include (1) the heats of conversion of $\text{S}\alpha$

(rhombic) to $\text{S}\beta$ (monoclinic), (2) the heat of fusion of sulphur, (3) the heat of conversion of $\text{S}\lambda$ to $\text{S}\mu$, (4) the heat of vaporization of sulphur, (5) the heat of dissociation of S_s to S_l , and (6) specific heat data for sulphur over the range 20 to 1,000 deg. C.

It is impossible to calculate exact thermal requirements for each of these steps since we have no data for specific heat of gaseous sulphur, much less for the heat of dissociation of S_s to S_l . Bearing in mind, however, that our distribution of heat losses must necessarily be only approximate, we may simplify the above course of events and, by making certain allowable assumptions, arrive at a value which will be well within the precision limits of the entire problem. The steps simplified may be taken as:



Based on constants listed in the appendix, these three steps from solid, to liquid, to gas, to high-temperature vapor show an investment of heat units for 64 grams of sulphur amounting to

$$1,750 + 29,390 + 10,700 \text{ cal.}^1 = 41,840 \text{ cal.}^2$$

The heat required to raise the equivalent 12 grams of carbon from 20 to 1,000 deg. C. is calculated as 3,530 cal.³ It is evident that the sum of calories represented by these two preparatory steps does not indicate the heat units expended in forming the equivalent amount of carbon bisulphide, inasmuch as there is a return of heat due to the exothermic vapor reaction as well as a return of heat to the entire system due to a cooling down of reaction products to about 200 deg. C.

Thomsen's value of -26,000 cal. for the heat of formation of gaseous carbon bisulphide and Koref's calculated value of +12,500 (from sulphur vapor) are quite consistent with the above heat values.

LOSS BY SUBLIMED S AND RADIATION

For purpose of heat-loss distribution, we must estimate the heat lost due to sulphur which has been vaporized but not converted to carbon bisulphide. Such byproduct sulphur leaves the furnace at comparatively low temperatures and would not represent a loss of 41,840 cal. per 64 grams. It is safe to omit the super-heating effect of the vapor, thus reducing the loss to 31,150 cal. per 64 grams of sulphur lost. A second subtraction of 1,750 cal. must be made in calculating electric heat loss, inasmuch as the solid sulphur is warmed up and melted by steam outside of the furnace. With a 20 per cent loss of original sulphur fed to the furnace, this electric heat loss amounts to 97,000 cal.⁴ per kilogram of product.

Loss of heat due to vaporization of water from charcoal containing 5 per cent moisture is a small item, amounting to only 5,000 cal. per kilogram of product.⁵

Radiation of heat from the furnace shell is quite the largest single heat loss realized. The units under consideration have about 320 sq.ft. (29.7 sq.m.) radiating surface. The average shell temperature approximates 100 deg. C. With a room temperature of 20 deg. C. and a conductivity factor⁶ of $K = 2$, the radiation loss totals 610,000 cal. per kilogram of product.⁷

¹Assuming 0.3 for sp. ht. of gaseous S.

²See appendix "B."

³See appendix "C."

⁴See appendix "D."

⁵See appendix "E."

⁶K = B.t.u per sq.ft. per deg. F. per hr.

⁷See appendix "F."

The heat requirements for the production of 1 kg. of CS₂ in the furnace described above may be summarized as follows:

	Cal.
1. Heat of formation* of 1 kg. finished CS ₂ ...	320,000
2. Loss due to drying charcoal.....	5,000
3. Loss of heat due to subliming S, which leaves furnace in worthless form.....	97,000
4. Radiation loss	610,000
 Total electric heat input.....	 1,032,000

The tabulated heat balance indicates a thermal efficiency within the furnace amounting to about 31 per cent. Converting calories to kilowatt-hours it is possible to express our results as 1 kg. of carbon bisulphide produced per 1.20 kw.-hr., or 1 lb. per 0.73 hp.-hr. These values agree well with actual operating data.

It is quite evident that the largest loss of power is due directly to radiation losses from the furnace. Any increase in capacity of the furnace tends to lower the per cent radiation loss and increase the efficiency. The maximum capacity or output per unit time is limited by the maximum allowable sulphur sublimation loss. A point may be reached where added load may increase prohibitively the cost of operation due to loss of chemicals, as well as increased maintenance costs. With current prices of chemicals and hydro-electric power, it may actually prove more profitable to operate the furnace at a somewhat lower thermal efficiency, and to sacrifice efficiency for equivalent financial return.

SUMMARY

1. A comparatively recent process for the manufacture of carbon bisulphide is described.

2. Actual plant data indicate that these units operate with a reasonably fair thermal efficiency.

3. An approximation of thermal losses is submitted.

In conclusion I wish to acknowledge the valued assistance rendered by Gordon Cave, who assembled and

*See appendix "G."

reviewed critically all references available pertaining to chemical and physical constants.

APPENDIX B

Note:—All calculations were made with slide rule. Calculations for bringing 64 grams of 2 gram atoms of sulphur from 20 deg. C. to 1,000 deg. C.

1. 20 deg. C. to 120 deg. C.
(64 g.) (0.18) (100 deg.) = 1,150 cal.
2. Fusion.
2 gram atoms \times 300 cal. = 600 cal.
3. Heating liquid sulphur.
(64 g.) (444 deg. — 120 deg.) (0.3) = 6,240 cal.
4. Vaporization of sulphur.
2 \times 11,580 = 23,160 cal.
5. Heating sulphur vapor to 1,000 deg. C.
Assume sp. ht. of vapor = 0.3
(64 g.) (1,000 deg. — 444 deg.) (0.3) = 10,700 cal.
Total = 41,840 cal. needed to bring 64 grams of sulphur to 1,000 deg. C.

Note:—In the furnace described, the melting is done outside the furnace by steam. This leaves about 40,090 cal. to be furnished by electric heat.

APPENDIX C

To heat 12 grams of carbon from 20 deg. to 1,000 deg. C.
(12) (1,000 — 20) (0.3) = 3,530 cal.
All this heat is supplied electrically.

APPENDIX D

Electric heat loss due to 20 per cent loss of sulphur in process.
Heat loss per 64 grams of sulphur so rendered worthless =
41,840 — 10,700 — 1,750 = 29,390 cal.
With 80 per cent yield of carbon bisulphide based on sulphur,
heat loss in furnace =
$$\frac{64 (1,000) (0.20) (29,390)}{76 (0.80) (64)} = 97,000 \text{ cal. per 1,000 g. CS}_2 \text{ produced.}$$

APPENDIX E

Electric loss due to distilling of moisture from charcoal.
$$\frac{12 (1,000) (0.05) (608)}{76 (0.95)} = 5,000 \text{ cal. per 1,000 g. of CS}_2 \text{ produced.}$$

APPENDIX F

Radiation loss from furnace per kilo of CS₂ produced.
 $K = 2 \text{ B.t.u.}$
 $K = 905 \text{ cal. per sq.ft. per hour per deg. C.}$
Production of furnace = 2,000 lb. per 24 hr.
Production of furnace = 83.5 lb. per hour.
1 kg. production requires 0.0263 hour.
Furnace surface = 320 sq.ft.
Average temperature of furnace surface = 100 deg. C.
Room temperature = 20 deg. C.
Then: Heat loss =
$$(320) (80) (905) (0.0263) = 610,000 \text{ cal. per kg. of CS}_2.$$

APPENDIX G

Heat of formation of 1,000 grams carbon bisulphide starting with liquid sulphur and ending with gaseous carbon bisulphide =
$$\frac{(1,000) [(-26,000) + (1,750)]}{(76)} = -320,000 \text{ cal.}$$

APPENDIX A—TABLE I

Carbon Bisulphide. Heat of Formation, Small Calories per Gram-Atom or Gram-Molecule		Constant	Authority	Compiler	Original Source	Method of Determination	Date
Substance	Condition						
Carbon bisulphide	Vapor from amorphous carbon and rhombic sulphur.....	—26010	J. Thomsen	Dammer Landolt-Börnstein-Roth	<i>Jahresberichte</i> , 1883, p. 159; 1885, p. 183 Thomsen's Researches, vol. 2, p. 411. German edition	Constant pressure	1883-1885
Carbon bisulphide	Vapor from amorphous carbon and rhombic sulphur	—25430	J. Thomsen	Dammer	<i>Jahresberichte</i> , 1883, p. 159; 1885, p. 183 Thomsen's Researches, vol. 2, p. 411. German edition	Constant volume	1883-1885
Carbon bisulphide	Vapor from charcoal and S ₂ vapor	+12500	Koref	<i>Chem. Abs.</i> , vol. 4, p. 1412	<i>Z. anorg. Chem.</i> , vol. 66, pp. 73-92	Calculation from equilibrium constants and equation of the reaction isochor	1910
Carbon bisulphide	Liquid from amorphous carbon and rhombic sulphur	—19610	J. Thomsen	Landolt-Börnstein-Roth	Thomsen's Researches, vol. 2, p. 411. German edition	Constant pressure	1883-1885
Monoclinic sulphur	From rhombic sulphur at 95.6°	—81	Reicher	Landolt-Börnstein-Roth	Inaugural diss. Amsterdam 1883, p. 76; <i>Zeit. Kryat.</i> , vol. 8, p. 593	Calculated	1883
	From rhombic sulphur	—86	Tammann	Landolt-Börnstein-Roth	<i>Z. anorg. Ch.</i> , vol. 63, p. 291	Calculated	1909
Sulphur α	From rhombic sulphur at 96°	—105	Kruyt	Landolt-Börnstein-Roth	<i>Chem. Weekbl.</i> , 1911, p. 647	Calculated	1911
	From sulphur λ	—420	Lewis & Randall	Landolt-Börnstein-Roth	<i>J. Am. Chem. Soc.</i> , vol. 33, p. 487	Calculated	1911

APPENDIX A—TABLE II
Carbon Bisulphide. Latent Heat in Small Calories per Gram-Atom or Gram-Molecule

Substance	Condition	Constant	Authority	Compiler	Original Source	Date
Sulphur	Fusion (115°)	299.761	Person	Castell-Evans	<i>Ann. chim. phys.</i> (3), vol. 21, p. 333	1847
		300.338		Landolt-Bornstein-Roth		
Sulphur monoclinic	Fusion (119°)	330.	Wigand	Landolt-Bornstein-Roth	<i>Z. phys. chem.</i> , vol. 63, p. 273	1908
Sulphur S_x	Vaporization (316°)	11,605.72	Person	Castell-Evans	<i>Pogg. Ann.</i> , vol. 70, p. 310, 386, possibly from <i>Ann. chim. phys.</i>	1847
Carbon bisulphide	Vaporization (0°)	11,580	Regnault	Landolt-Bornstein-Roth	<i>Mem. de Paris</i> , vol. 26, p. 761, 811, 819, 829, 835, 849, 857, 913	1862
Carbon bisulphide	Vaporization (0°)	6850	Winkelmann	Landolt-Bornstein-Roth	<i>Wied. Ann.</i> , vol. 9, p. 208, 358	1880
Carbon bisulphide	Vaporization (14.1°)	6610	Koref	Landolt-Bornstein-Roth	<i>Ann. Phys.</i> (4), vol. 36, p. 56	1911
Carbon bisulphide	Vaporization (46.1°)	6380	Wirts	Landolt-Bornstein-Roth	<i>Wied. Ann.</i> , vol. 40, p. 446	1890
Carbon bisulphide	Vaporization (46.2°)	6600	Andrews	Landolt-Bornstein-Roth	<i>London Chem. Soc.</i> , vol. 1, p. 27	1849
Carbon bisulphide	Vaporization (46.6°)	8050	Person	Landolt-Bornstein-Roth	<i>Pogg. Ann.</i> , vol. 70, p. 310, 386, possibly from <i>Ann. chim. phys.</i>	1847

APPENDIX A—TABLE III
Carbon Bisulphide. Specific Heat in Calories per Gram per Deg. C.

Substance	Range	Constant	Authority	Compiler	Original Source	Date
Sulphur 2 yr. after fusing	15-97°	0.1764	Regnault	Castell-Evans		
Sulphur, rhombic	17-45°	0.163	Regnault	Castell-Evans		
Sulphur, liquid	119-147°	0.2346	Person	Castell-Evans		
Sulphur, liquid	160-201°	0.279	(Deysey)	Landolt-Bornstein-Roth	<i>Compt. rend.</i> , vol. 123, p. 305	1896
Sulphur, liquid	160-233°	0.300	(Deysey)	Landolt-Bornstein-Roth		
Sulphur, liquid	160-264°	0.300	(Deysey)	Landolt-Bornstein-Roth		
Sulphur, liquid	201-233°	0.331	(Deysey)	Landolt-Bornstein-Roth	<i>Compt. rend.</i> , vol. 123, p. 305	1896
Sulphur, liquid	233-264°	0.324	(Deysey)	Landolt-Bornstein-Roth	<i>Compt. rend.</i> , vol. 123, p. 305	1896
Sulphur, rhombic	0-32°	0.1719	Wigand	Landolt-Bornstein-Roth	<i>Ann. Phys.</i> (4), vol. 22, p. 64	1907
Sulphur, rhombic	0-95°	0.1751	Wigand	Landolt-Bornstein-Roth	<i>Ann. Phys.</i> (4), vol. 22, p. 64	1907
Sulphur, rhombic	23-92°	0.1759±5%	Kurbatov	Chem. Abs., vol. 5, p. 607	<i>J. Russ. Phys. Soc.</i> , vol. 41, p. 311-2	1909

APPENDIX A—TABLE IV
Carbon Bisulphide. Specific Heat in Calories per Gram per Deg. C.

Substance	Range	Constant	Authority	Compiler	Original Source	Date
Carbon bisulphide	0	0.23523	Regnault	Castell-Evans	<i>Mem. de l'Acad.</i> , vol. 26, p. 262	1862
Carbon bisulphide	0	0.22958	Hirn	Castell-Evans	<i>Ann. chim. phys.</i> (4), vol. 10, p. 32	1867
Carbon bisulphide	18	0.242	Forch	Landolt-Bornstein-Roth	<i>Ann. Phys.</i> (4), vol. 12, p. 202	1903
Carbon bisulphide	30	0.24012	Regnault	Castell-Evans		
Carbon bisulphide	30	0.23938	Hirn	Landolt-Bornstein-Roth	<i>Mem. de l'Acad.</i> , vol. 26, p. 262	1862
Carbon bisulphide	30	0.2388	Hirn	Landolt-Bornstein-Roth	<i>Mem. de l'Acad.</i> , vol. 26, p. 262	1862
Carbon bisulphide	60	0.24897	Hirn	Castell-Evans		
Carbon bisulphide	80	0.260	Sutherland	Castell-Evans	<i>Phil. Mag.</i> (5), vol. 26, p. 298	1888
Carbon bisulphide	100	0.26168	Hirn	Landolt-Bornstein-Roth	<i>Mem. de l'Acad.</i> , vol. 26, p. 262	1862
Carbon bisulphide	120	0.276	Sutherland	Castell-Evans		
Carbon bisulphide	160	0.2882	Hirn	Landolt-Bornstein-Roth	<i>Phil. Mag.</i> (5), vol. 26, p. 298	1888
				Landolt-Bornstein-Roth	<i>Mem. de l'Acad.</i> , vol. 26, p. 262	1862

Condition of the German Paper Industry

According to recent advices from the American Consul-General in Berlin and from the Consuls in Breslau and Frankfort on the Main to *Commerce Reports*, the paper trade in Germany is suffering at present from a serious shortage of materials, particularly newsprint. Owing to the low value of the German mark the importation of paper in large quantities is extremely difficult and the trade is compelled to confine itself largely to paper of domestic production. Paper prices are constantly rising, as are the prices on all commodities. Very little is being exported, and most of the mills are sold for months in advance.

This situation has made the position of newspaper publishers so embarrassing that many papers all over Germany have been forced to suspend publication entirely or have combined with other journals. Some that formerly had two or three issues daily now have only one.

The condition of the Silesian paper industry has recently become worse. Large deliveries of wood on reparations have necessitated the importation of pulp wood from Czechoslovakia and Poland. Because of the uncertainty of rates of exchange, prices have continually increased. The leading manufacturers of wood pulp in the Breslau consular district state that they are not in a position to export and can scarcely produce enough for home demands.

The paper manufacturers are overrun with orders and cannot make deliveries because of the difficulty of obtaining raw materials. At present large orders for

paper cannot be filled within the next 4 or 5 months. Toward the end of 1921 the buyers, anticipating a large increase in prices, placed heavy orders, and as a result the factories were completely sold out and had no stocks left on hand. In spite of the fact that production during the first 6 months of this year was on an average 60 per cent greater than during the same period of 1921, there is still a scarcity of paper.

GERMAN PRICES FOR CELLULOSE AND PAPER

The price for cellulose has been set by the manufacturers at 170 per cent more than the August, 1922, price. The paper manufacturers demand three times as much for September deliveries as for August deliveries.

The following comparative prices, in marks, for 10,000 kilos (22,048 lb.) of print paper prevailed during the first 3 months of 1922: January, 70,000; February, 73,000; March, 82,000; April, 128,000; May, 159,000; June, 166,000; July, 200,000; August, 280,000.

According to present information, 700,000 marks per 10,000 kilos will be demanded for print paper in September. This is 350 times the pre-war price.

Ordinary writing paper, which was quoted at 95 marks per kilo in July, 1922, advanced to 132 marks per kilo at the beginning of August, and increased still further to 192 marks per kilo by the end of August. During the same period ordinary business envelopes rose in price from 85 marks per 1,000 in July, 1922, to 145 marks per 1,000 at the beginning of August, and 450 marks per 1,000 by the end of August.

Modern Practice In Manufacture and Applications of Steamed Ground Wood

BY A. O. BRAGG

Part II of a Description of the
Present Status and Practical
Possibilities of This Process for
Paper and Board Manufacture, in
Which the Operation of a Modern
American Plant Is Discussed

IN THE preceding installment of this article* the theory of steaming wood preparatory to grinding was discussed and the equipment used in a modern American plant was described from the wood room to the jordans. In the following pages, the operation of this equipment will be described, with special attention to the so-called operating kinks and practical considerations.

WOOD ROOM

Wood room operations consist of cutting to the usual 2-ft. lengths and, where necessary, barking. Logs 2 ft. long are preferable for charging cookers, as mechanical complications and labor cost are increased by attempting to cook longer logs; hence this sawing should be done before the cookers are filled.

As previously indicated, barking may or may not be necessary, according to conditions. The determining factors are the type of cooker used and the product in which the pulp is to be used. For example, it would be needless and a waste of money to bark wood to be used in trunk board or as a filler in a board between two outside liners of other pulp, so far as appearance is concerned, and the strength of pulp from rough wood would not be appreciably less than from peeled wood. Ordinarily, when used for paper, it should be barked. For use in wrapping paper, for instance, where bark specks might cause holes in going through the calenders or detract from the appearance, the bark should be removed. No barkers will be needed with rotaries, as before stated, but barkers of some type are necessary with vertical cookers. Since the fine bark dust is not usually objectionable in the dark colored papers for which this pulp is suitable, the heavy wood loss from knife barking to obtain absolutely clean wood is not usually necessary. A fine grade of butchers' wrapping paper is being made of pulp from wood barked exclusively in the rotaries, where it is also steamed, the amount of slivers or brooming being very small and no bark being visible in the sheet.

ROTARY STEAMERS

Below is given an operating schedule using rotary boilers 16 ft. in diameter, cooking for 12 hours, and providing for the maximum production from the equipment. It will be understood that the actual time in completing a cycle of operations is dependent on the time the wood is cooked. The equipment under consideration is that shown in Fig. 2.

Charging.—The chute is adjusted to discharge into the manhole of boiler to be filled by placing baffle board across the opposite side. The conveyor is started and boiler filled with 6 cords of rough or 7½ cords peeled wood from wood room. Then the conveyor machinery is stopped and a square-braided hemp gasket placed on the seat of the manhole cover, after which the manhole

cover is lowered in place by Triplex block and the bolts tightened.

Cooking.—The reducing valve is set at pressure to be used for the cook and the steam turned on. The boiler is kept stationary until the charge is ready for barking. If boiler is tight, it requires about 1½ hours to get steam up to 20 lb. pressure. If boiler is not tight, leaks will prevent pressure building up at all. Condensed water is drained out every hour.

Barking.—About 1½ hours before the end of cooking time the boiler is started rotating and kept going until end of cooking period.

Dumping.—The cooker is stopped in such a position that the manhole cover can be reached by the Triplex block chain and lifted off. Then the boiler is started rotating again and this is continued until the cooker is empty. Rotation should be stopped in such a position that pulpwood will drop into manhole from chute for the next cook. It takes about 1 hour to dump a digester.

The barking is quite effective, only about 3 to 5 percent of the logs having any bark still clinging to them and this bark is much disintegrated and loosened.

Dumping is rather a dangerous operation. At each revolution of the boiler more or less wood falls out together with finely divided bark. While the outlet is down and the digester is discharging, the workman must stand aside, out of reach of the falling logs. During the upper half of the revolution he "picks" logs onto the conveyor which takes the steamed wood to the grinders. When the pile accumulating on the high end of the slope gets too high, the wood falling from the boiler tends to push this pile down the slope toward the conveyors, and this danger must also be watched. Since the rate of dropping exceeds that at which one man can "pick" logs onto the conveyor, it is customary to stop the boiler until the accumulated pile has been disposed of, which time is included in the hour specified above. The number of logs dumped out at each revolution varies, as sometimes the manhole clogs up, owing to the arrangement of the logs inside. Much of the bark finds its way to the rack, being carried onto the conveyor while "picking" the logs. The excess bark is shoveled out through an opening in the wall of the pit kept closed by a door (Fig. 2) and thrown away. Its fuel value is low, because of the high moisture content.

VERTICAL DIGESTERS

The operation of these cookers will be for the most part self-evident from the drawing. The wood bins are refilled while cooking is going on, dropping just enough wood over each cooker to fill it, which amount is measured in the wood room before putting on the conveyors. It should be mentioned that, when filling, some logs do not fall into the opening in the cookers, but fall on the floor. These must be put in by hand after the proper cordage has been dropped from the bin. As there is considerable danger from falling logs, no

*The first installment of Mr. Bragg's article was published in *Chem. & Met.*, vol. 27, No. 16, p. 793, Oct. 18, 1922.

workmen should be permitted on the third floor during the time logs are falling from the bin.

Dumping is practically instantaneous when the conical bottom has been lowered far enough to permit the logs to fall out. There is no occasion for anyone to be in the discharge pit, except to clean it out during shutdowns; hence there is no danger to the workmen from dumping. The hydraulic ram is provided with automatic stops. The pressure or temperature gages being on the first floor, the cooking requires very little time or attention, pressure or temperature readings every hour or so being all that is necessary.

As with the rotary, the steam should be passed through a locked pressure-reducing valve before admission to the boiler, to prevent possible explosion. At the end of a cook the steam remaining should preferably be blown off into boiler feed water by an insulated pipe going to the power plant and the whole steamer should be thoroughly insulated by suitable magnesia covering.

BACHE-WIIG PROCESS, ENGE PROCESS

The Bache-Wiig process² consists of boiling the blocks under pressure in a salt solution for 6 or 7 hours. This is said to exert a peculiar softening effect on the wood, the fibers disintegrating more readily with scarcely any loss in weight and a much stronger white pulp being obtained which takes color well. It is claimed that by the use of such pulp alone, a sheet fully as strong as one made of 80 per cent ordinary ground wood and 20 per cent sulphite may be obtained. The extra cost per ton, figuring on a 100 ton per day production, is estimated at \$0.99 in 1916, necessitating for the processing alone a plant investment of \$72,500. It is stated that the use of 5 per cent of sulphite is advisable with newsprint because of the better finish obtainable. The savings using 5 per cent sulphite and 95 per cent Bache-Wiig ground wood, as over 25 per cent sulphite and 75 per cent ordinary news ground wood, are estimated at \$3.25 per ton.

The Enge process,³ German patent 315,679, claims the production of a very tough ground-wood fiber with absolutely no discoloration—i.e., the color is that of the natural ground wood. The results obtained from tests on Enge pulp by the Laboratory for Testing Materials do not bear out these claims. In this method the wood is saturated with water at 80 deg. C. and kept boiling for 6 to 8 hours under a $\frac{1}{2}$ atmosphere pressure. Grinding is done lengthwise, the axis of the log being kept at an angle of 10 deg. to the face of the stone, which increases the fiber length.

The pulp is darker in color than untreated pulp, but not so dark as steamed pulp. As would be expected, the process is rather slow. The breaking strength of newsprint made wholly of Enge pulp was found to be slightly more than for ordinary newsprint, but because of the brittleness of the pulp was much inferior to it in the number of foldings it would stand.

The advantages of the Enge process over ordinary wood steamings are not very evident, and it would seem that the relatively slight treatment which could be given to wood by it, necessary to keep the pulp from becoming too dark in color to be used for newsprint, would not effect benefits commensurate with the cost of treatment. The Bache-Wiig process is based on a scientifically correct foundation, the sodium chloride uniting with the brown coloring matters formed, to give water-soluble

sodium salts of these dyes and thus preventing the discoloration of the pulp caused by Enge's process. However, with the recent advent of improved methods of dressing stones to obtain ground wood of sufficient strength for use in newsprint without sulphite, the investment and operating costs for the Bache-Wiig process would seem to be too heavy as compared with these more recent developments.

PROPER COOKING CONDITIONS

A generally inclusive and definite statement as to the proper cooking conditions to be used with different woods cannot be formulated, the number of variables being too large. The exact conditions are something which each mill must decide for itself. All the following factors have a bearing, directly or indirectly, on how long and with how much steam pressure a given wood should be cooked:

1. Moisture content of wood.
2. Pitch or rosin content of wood.
3. Seasoning the wood has had.
4. Time of year in which wood is felled.
5. Density of wood species used.
6. Soundness and freedom from decay and fungi.
7. Diameter of logs.
8. Color of pulp desired.
9. Strength of pulp desired.
10. Product in which pulp is to be used and its requirements as to color, strength and finish.

11. Paper machine equipment available and production desired from it, and if addition and alterations can be made to it to increase production.

12. Balance of cost—i.e., striking a balance between maximum strength or depth of color of pulp desired and permissible limit of cost for steaming operation (which involves yield per cord) and whether a slight increase in strength obtained by cooking beyond a certain period will not be offset by greatly increased cost and reduced yield.

The relative influence of these factors will perhaps be more evident after giving some present cooking practices used with different woods and for different products, describing the nature of the pulps obtained and the operation conditions for the machines.

WRAPPING PAPER

The first woods considered will be a mixture of scrub pine and white pine. These woods are now being used for pulp to make an excellent grade of butchers' wrapping paper. The cooking conditions are varied according to the condition of the logs, as determined by visual inspection and personal judgment. The limits are from 9 to 16 hours at 13- to 20-lb. gage. All dry, well-seasoned logs are treated for 9 to 12 hours at 13- to 16-lb. pressure; all green, freshly felled wood requires from 16 to 20 lb. applied for 12 to 16 hours. Mixtures of dry and green woods are treated in proportion to the amounts of the woods of different moisture contents present. Thus, a mixture of equal parts green and dry wood would be cooked at 16.5 lb. for 12.5 hours, the mean of the maximum and minimum limits. If all the wood was extremely green-steamed—for instance, the day after cutting in the spring when the sap is up—20 lb. for 16 hours or longer would be required to effect thorough saturation and freeing from pitch, while if all the wood has been stored in a dry place for 3 or 4 years, 9 or 10 hours at 13 lb. would be sufficient. Under these conditions 8- to 9-in. sticks are completely saturated, all rosin and pitch removed and suitable pulp obtained. Larger sticks are likely to be incompletely penetrated and to have some rosin still present. If many such logs are noticed in the wood room when sawing, they should be split before cooking.

²Paper, April 19, 1916.

³Paper, Sept. 6, 1916.

In grinding, any good medium grit stone is used. Like any ground wood, the quality of the pulp depends largely on the dressing given the stone and the production on the speed and pressure used. In this case, an 8 to 1-in. diamond burr is used, keeping the stone dull. The pressure is 60 to 70 lb. to avoid the crushing effect on the fibers by higher pressures especially noticeable in dull stones. At these pressures a stone will grind about 4½ cords per 24 hours with a three-pocket grinder. The yield is about 2,200 lb. of pulp per cord, which corresponds to a 24-hour production per grinder of 5 tons of pulp. The power consumption per grinder runs from 280 to 290 hp., or 56 to 59 hp. per ton per 24 hours.

For the wrapping paper mentioned above, 60 per cent sulphite and 40 per cent of the steamed pine ground wood are furnished. It is found that this paper takes and keeps a better finish and has a higher Mullen test if the pulp is cooked as above than if it is steamed at a higher pressure for shorter periods.

This ground wood, and any ground wood made from wood of similar fiber length similarly treated, can be classified as an exceptionally strong and high grade of ground wood, except, of course, as to color. It is much stronger and tougher than any untreated ground wood made from wood of the longest fibers, in spite of recent developments in stone dressing. It is still considerably weaker than sulphite. An attempt was made to produce butchers' wrapping paper from the steamed ground wood alone, but the sheet was found to be too low in tensile strength, and the above formula was adopted. Even using only 40 per cent steamed pulp, 40 per cent sulphite is replaced and its cost and freight saved. The heavier weights of this grade of paper can use a higher percentage of steamed ground wood than this, a 60-lb. sheet being perfectly satisfactory when containing 75 per cent steamed ground wood and 25 per cent sulphite. The stock dries well on the driers. As much as 46 tons of this paper, basis 24 by 36, 60 lb., can be made on a Fourdrinier trimming 105 in. with twenty-six 48-in. driers.

The pulp is a maple or tan color, verging on the orange. It is found from experience that when cooking these pines for longer than 20 hours the increased cost and darkening of the fibers offset the slightly improved Mullen and tensile strength obtained, so that this figure can be considered as an economical maximum for cooking time for similar woods. The fibers are long and the pulp is tough and tears with difficulty. It seems to be a trifle softer than untreated pulp when dry. For use in this kind of paper, careful jordaning is relied on to keep up the Mullen of the sheet, rather than the beaters, as previously mentioned. The Mullen test obtained from this pulp alone, with a Fourdrinier formation, is about 4 lb. per 0.001 in., which is rather more than would be obtained on the usual cylinder machine. The stock is kept very thin, 0.110-in. centrifugal screen plates being used.

USE IN BOARD

Some cylinder machine applications of steamed pulp will now be considered. These include quite a variety of board products, such as wallboard, trunk and suitcase board, leather board, various container boards, etc., where the color is not objectionable and the pulp can replace more or less unbleached sulphite. It also serves to increase the strength over that obtainable from ground wood or waste papers. It is not sufficiently strong to replace any pulp stronger than sulphite.

Spruce, steamed at 50 to 55 lb. for 14 hours, and a

mixture of birch (50 to 75 per cent) and maple (50 to 25 per cent), or either alone, similarly treated, yield pulps particularly adapted to make certain strong boards. This steamed spruce ground wood is now successfully used alone for solid jute boards in its natural color. Such boards are not brittle, are tough and are good binders. The color of the pulp, and hence of the boards, varies from a light to dark tan, sometimes with a slightly reddish cast. Used as outside liners in filled jute board, the bending quality is improved, and the strength of the board increased over plain chip for the same caliper. All these boards take and retain a good water finish and are good imitations of genuine jute. Spruce and other coniferous woods are steamed under the above conditions for the production of brown pulp for suitcases, trunks, etc., and for use as a filler in the manufacture of leather board, mill board, etc.

PULPING HARDWOODS

The pulp obtained from grinding hardwoods which have been steamed as above is quite different in some respects from steamed spruce pulp. With both the hardwood and spruce a 6 to 1-in. diamond burr is usually used, keeping the stones dull. The more seasoned and drier these woods are the less cooking they require. Wood seasoned for 3 years, which is apt to be rather punky, would be steamed for 14 hours at 30 lb., which can be considered as the minimum limit for this class of pulp.

Steamed hardwood pulp is of small tensile strength, tender and very likely to cause trouble in lapping and on the paper machine owing to these characteristics. When dry it makes a very rigid but brittle sheet. While the fibers are short and lack the felting power of steamed spruce, they are still not as slow as the steamed spruce ground wood, which is conceded to be one of the most difficult stocks to handle on a cylinder machine. The "footage" obtainable from the steamed hardwood is comparatively good in spite of the density and weight of the pulp. The cooked hardwood logs are best ground with steamed spruce wood in the proportions of one pocket of steamed spruce and five pockets of steamed hardwood. This permits lapping on the wet machine and easier running on the cylinder machine owing to the added tensile strength from the steamed spruce. In some cases the cooked spruce can be omitted from the grinders and 20 to 30 per cent of natural ground wood and 5 to 10 per cent sulphite pulp used to give strength and freeness to the stock and prevent machine trouble. Though steamed hardwood pulp has a low tensile strength, the Mullen test of boards made from it runs high on account of their great rigidity.

This pulp is much different in color and darker than steamed spruce, being a rich chocolate shade. For thin boards which must have both puncture resistance (rigidity) and tensile strength, a sheet made up of equal caliper plies of cooked spruce and cooked hardwood makes an excellent combination. Used as a filler and bottom liner, with a top liner of natural ground wood and sulphite in suitable proportions, very strong yet attractive looking boards are made. Where very thick, heavy boards of extreme rigidity are desired, three or four plies of steamed hardwood boards, pasted together with sodium silicate on a sheet pasting machine, will give a product with almost the rigidity and smoothness of solid wood, suitable for making the largest and strongest trunks and for other products which may be subjected to extremely severe usage.

Wallboard made entirely from steamed wood pulp would be too expensive, owing to the large weight per square foot giving small "footage" per ton of board; but one or two cylinder plies on the inside add much to the strength and rigidity so important in these products. The use of steamed ground wood in products of this character is patented.

Since all steamed ground-wood pulps are very slow, as compared with untreated wood similarly ground, some suggestions regarding proper construction and operating conditions for the paper machine might be of help. Owing to the difficulty in handling this stock on the machine, the machine crews must be of the very highest caliber and skill, preferably those who have previously handled slow stock on multicylinder machines.

In the first place, because of the slowness of the pulp, it is imperative that as little stock as possible be applied to any one cylinder mold in building up the sheet. This smaller amount permits the water to drain out more quickly from the greasy stock, thus reducing the likelihood of "blows." "Blows" in board are usually caused by an outside cylinder ply being more compact and thus slower than the filler stock. Consequently the press rolls cannot squeeze out the water from the liner fast enough, but instead the water in it acts something like a lever, forcing the liner from contact with the filler ply.

Referring again to the necessity of applying as little pulp as possible to each cylinder mold, in order that thick boards may be made, machines with unusually large numbers of cylinders are used. Trunk board, for instance, is made of steamed spruce and hardwood applied to from nine to twelve cylinder molds, rarely or never less than nine. As an approximate estimation of the caliper of dried pulp applied by each mold, this should run from 0.003 to 0.004 in., as contrasted with 0.005 to 0.006 in. for waste paper boards and 0.006 to 0.007 in. for coarse free ground-wood stock such as wallboard single-ply, for which six cylinders are used in place of nine or more.

SIZE OF VAT CIRCLE IMPORTANT

Another important factor in construction is the size of the vat circle—the radial distance from the cylinder mold wire to the inside surface of the cylinder vat lining. If this clearance is small, say 3 to 4 in., especially with very wet stock, the fiber will be so compact that a dense, heavy, wet sheet is formed from which the water is very slowly removed; while a clearance of 6 to 8 in. makes a sheet which, while not giving quite the finish of the more compact stock, gives greater production and less trouble because of being freer and more open. The "footage" of board obtainable per ton of pulp will be greater, since it will run lighter in weight per unit of caliper.

To permit free and quick passage of the water pressed out, the felts used should be as open and coarse as consistent with the requirements of the sheet as regards smoothness and felt marks. All couch rolls, baby press rolls and main press rolls must be kept in perfect condition and alignment to prevent damp spots and streaks in the sheet.

The satisfactory operation of a board machine on this pulp involves more difficulties than a Fourdrinier. Using slow stock on a Fourdrinier, the suction is increased on the suction boxes and suction press roll. In a multicylinder steamed ground-wood board machine, the suction on each cylinder mold must be reduced and

kept uniformly so, by lowering the head to 3 to 4 in. or less as compared to 13 to 14 in. on free stock. The driers must be regulated to dry the sheet slowly and gradually, to avoid blistering.

Where the quality and thickness warrant, refined ground-wood screenings are useful in reducing weight and freeing up the stock, and are cheap; refined sulphite screenings, though darker in color and more expensive, both free and increase the strength of the stock.

The following estimate of production possible from a cylinder machine operating on steamed pulp is probably conservative. If a machine making 90 tons of a pure uncooked spruce ground-wood board were put on 20 per cent refined ground-wood screenings and 80 per cent steamed ground wood, by working much harder the machine crew could maintain an output of about 75 tons.

GENERAL CONSIDERATIONS IN COOKING CONDITIONS

Table I summarizes the cooking practice for the various woods considered in this article and will be found suggestive in deciding on how best to cook a given wood for certain uses.

TABLE I—SUMMARY OF COOKING PRACTICE

Wood	Length of Cook, Hr.	Steam Pressure, Lb.	Natural Fiber Length, mm.	Color of Pulp	Tensile Strength	Other Characteristics
Maple, Birch:						
Dry.....	14	30	1.5	Dark	Low	Rigid.
Green.....	14	50 to 55	1.5	Chocolate	Low	Brittle. Compact. High Mullen. Tough.
Spruce:						
Dry.....	14	30	2.8	Light to	High	Elastic. Good bending.
Green.....	14	50 to 55	2.8	dark tan	High	Not so rigid as hardwood.
Scrub pine, White pine:						
Dry.....	9-12	13 to 16	2.8	Same as spruce	High	Same as for spruce pulp.
Green.....	12-16	16 to 20	2.8		High	

Considering again the twelve factors determining cooking conditions, the fundamental one is No. 10—"Product in which pulp is to be used and its requirements as to color, strength and finish." This automatically specifies the color or strength the pulp must have and hence pressure and duration of cook that will give them.

In carrying out the trial steaming tests to determine the best conditions, no logs should exceed a certain maximum diameter, say 8 to 9 in., and their moisture content should be approximately constant for all test runs and either be extremely green or extremely dry, preferably the former, as the wood of high moisture content will require the most severe conditions. Practically, this means that all the wood used should have been felled at the same time of year and have been similarly dried afterward, if seasoned wood is used. In this way all the data obtained will be of unquestioned value for the purpose. Moreover, the wood should be of the same species or at any rate of species of practically equal densities. Steaming, grinding and machine runs under these known conditions having been carried out and all pertinent data recorded, if a satisfactory product has been obtained, factors 11 and 12 can be considered and the conditions modified so far as possible to conform with these two factors. As a final step in the standardization process, satisfactory cooking conditions should be found for woods containing the opposite extreme of moisture to the original content selected.

In connection with factors 11 and 12, dealing with the construction and financial conditions at the mill, the following may be of help. Practical economic considerations would dictate that the total cost for the steaming operation alone (not including wood preparation but including everything from power to elevate wood to cookers, to labor or power to take steamed wood to grinders) should not be more than three-quarters of the difference between the cost of natural ground wood and No. 2 unbleached sulphite pulp. Above this fraction of the difference in cost it would doubtless pay in the long run to use the unbleached sulphite rather than make steamed ground wood at all. Ground wood is now \$32 a ton and No. 2 unbleached sulphite \$48, a difference of \$16. Three-quarters of the difference, or \$12, is therefore the economical limit. There are practically no cost figures available on the steaming operation, and conditions vary greatly, so that such figures would not mean very much at best. The following data may help in approximating such cost:

1. Interest on investment would be comparatively small, a few cents per ton with rotaries; but would be much larger with the building, wood bin, conveyors, cookers and miscellaneous equipment necessary when the vertical type is used. The operating cost exclusive of interest charges would be less for the vertical type. Vertical cookers or steamers of the type and size indicated in the drawing can be obtained now for \$5,050 each. Two would probably be necessary for most economical operation, as previously pointed out.

2. Steaming at 15 to 20 lb. for 15 hours, using unjacketed rotaries and not reclaiming residual steam by absorption in boiler feed water, the coal consumption is estimated to be 1 ton coal per cord steamed. At an evaporation of 9 to 10 lb. water per pound of coal, this would figure out as 4,000 to 4,500 lb. steam per cord of wood. At a yield of 2,200 lb. AD pulp per cord, this would be 0.227 ton coal per ton AD pulp.

3. Where wood must be barked before cooking, two men per shift are required. Where unbarked wood can be used, one man per shift is sufficient. In both cases it is necessary that they devote their entire time to duties directly and indirectly connected with its operation.

CONTROL OF OPERATIONS

Satisfactory cooking conditions once having been worked out for a particular mill, care should be exercised to see that no woods varying widely in density from that considered in the standard conditions are used. Care should be taken that no wood with unusually large amounts of pitch are cooked under conditions suitable only for smaller amounts of pitch. Of course the moisture content of the logs will have to be watched and conditions varied as may be necessary. If the wood seems to be unusually wet or dry, occasional moisture determinations will aid in avoiding undercooked wood and machine trouble. The value of the product, as compared to higher grades of pulp, is not enough to warrant any great expenditures for elaborate control work for moisture, yields, etc.

POSSIBLE FUTURE APPLICATIONS OF THE PROCESS

Steaming hardwoods and pitchy woods, neither of which give satisfactory ground wood in the untreated state, would seem to offer fields for wider use of the steaming process, to replace, in part, unbleached sulphite in locations where few of the local woods are adapted to the sulphite process.

Woodfords, Me.

Groove Inspection of Thermit Welds

BY J. H. DEPPELER

Chief Engineer, Metal & Thermit Corporation

ONE fact that has been responsible more than any other for retarding the progress of welding is that when a weld is made it has been impossible to determine without destroying it what strength is definitely assured and safe to allow. An examination of the surface of welds does not reveal this. For example, in gas or arc welding, the operator can carelessly leave voids and laminations during the work, and yet finish the surface of his weld so smoothly that these cannot be detected. To show another example, there may be numerous burned spots and other oxide inclusions which are hidden and yet render an apparently strong weld



FIG. 1—GROOVES CUT IN COLLARS OF THERMIT WELD MADE IN 9x10-IN. BARS

absolutely useless. It is on this account that technical societies and associations interested in the possibilities of welding have greatly restricted the permissible applications to parts which are stressed relatively light, or in those whose failure will involve small risks.

It is highly important, therefore, to consider the fact that Thermit welding permits the drawing of proper conclusions as to the strength of welds. If the proper amount of Thermit has been used and the work has been done by a skilled operator, it is impossible to have such defects as lack of fusion. Oxide inclusions, such as those formed during the preheating and adding of weld metal, or those remaining on unclean surfaces (due, for example, to failure properly to clean scale from wrought-iron sections before welding) have always resulted in Thermit welding in only one type of defect—i.e., blow holes. Due to the natural tendency of the gases to rise in the molten mass, this defect, if present at all, will always be present in the Thermit steel collars. It is apparent that an examination internally of the collar or excess metal can be made without affecting the strength of the weld. Thus the unsound welds can be found and condemned.

In practice, this examination is made as shown in Fig. 1 by gouging deep grooves in the collars parallel with the axis of the piece, these grooves reaching almost to the original sections itself. It is unnecessary to cut as many as shown, since we have found that two such grooves on the four sides of a Thermit weld are sufficient. If these grooves are observed to be free and clean from blow hole defects, the inspector may be assured that the weld itself is sound.

New York City.

Synopsis of Recent Chemical & Metallurgical Literature

Deterioration of Stored Cement

Details of a study of the storage and transportation of portland cement, with a bibliography on the subject, are given in Serial 2,377, obtainable from the Bureau of Mines, Washington, D. C.

Deterioration of cement stored in bulk is less than in bags, owing to the smaller area exposed, states the United States Bureau of Mines, as the result of an investigation to determine the cause of deterioration of portland cement during storage and transportation. Hydration takes place only at the exposed surface, and the bulk of the cement is unaffected. Cement transported in bulk must be shipped in a tight, closed car, and must be protected from moisture during loading, shipping and unloading. Preferably it should be used immediately after unloading at the point of destination. This practice is now followed by several manufacturers and where conditions are suitable it is becoming more common as its advantages are seen. Shipping in bulk effects a saving by eliminating the use of bags—which is an important item in the cost of cement—and it should also permit a saving in freight rates.

Air Conditioning in a Munitions Factory

A criticism of the technical literature on the subject of air conditioning, on the ground that it is deficient in detailed and critical study of the actual performance of recognized ventilation systems under the normal conditions of everyday use, introduces a pamphlet which has just been issued by the United States Public Health Service and written by C. E. A. Winslow and L. Greenburg. It is said that the details of installation are recorded in technical literature very fully, to the neglect of the results obtained in actual everyday operation. The authors have carried out investigations in a munitions factory which included over one hundred separate buildings. The greater number of the workrooms involved no special air conditioning problems and furnished good examples of the ordinary factory workroom ventilated by windows only, but thirteen of the workrooms studied were equipped with systems of fan ventilation, many of them designed to combat heat hazards of considerable magnitude.

It was found that in most of the rooms requiring no special ventilation the general tendency was to maintain a temperature slightly above optimum working conditions. A temperature of 68 deg. F. should be maintained and it is said that the systematic observation

of a thermometer placed in every workroom and the intelligent regulation of heating appliances are all that is necessary to provide this condition. In other words, to quote the words of the authors, "A thermometer and a little common sense will solve a great many ventilation problems."

A problem was encountered in the annealing shop, which contained a large number of rotary furnaces on each side of the room. The temperature in these furnaces was about 1,200 deg. F. A system involving two air washer fans, each having a capacity of 45,000 cu. ft. per minute, was arranged to deliver air to both sides of the room at the floor level, with another duct along the center of the ceiling. It was found that this system was amply sufficient to keep conditions good when the weather was cold, although the CO₂ content of the air rose to as high as 14 parts, due no doubt to the presence of furnace gases. Other detailed studies were made in the shell-washing shop, where the heat and humidity were controlled by fan ventilation. Curves are given which show very plainly the changes in atmospheric conditions in this wash shop caused by interrupting the fan ventilation. In general, it is concluded that while conditions in this workroom under normal operation were by no means ideal, the temperature being sometimes over 80 deg., they would be almost unbearable without the very efficient system of ventilation that has been installed.

In conclusion, the authors state that in the summer time while the hazard incident to processes involving the production of excessive heat can and should be mitigated to some extent by a system of ventilation which produces vigorous air movement, it cannot be fully controlled except by special systems of air cooling which involve considerable expense, but which must be accepted as an inevitable incident of certain industrial employments. Where this is the case, the effect of the high temperature should be minimized by short spells of work alternating with rest.

Tellurium and Its Uses

Detailed information regarding the properties, uses and metallurgy of tellurium is given in Serial 2,385, by H. A. Doerner, chemist, which may be obtained from the Bureau of Mines, Washington, D. C.

The finding of new uses for the mineral tellurium would render marketable a byproduct of which the copper refineries of the country can produce 125,000 lb. annually but for which there

is little present demand. Although the mineral possesses various rather remarkable characteristics, present uses are so limited that the demand is supplied by a few hundred pounds per year.

Most gold and silver ores and particularly copper ores contain tellurium. In the course of smelting and refining these ores, tellurium is found in concentrated form in the flue dust of smelters, electrolytic slimes, and in the fumes and slags resulting from cupellation. The whole commercial supply of the element is obtained as a byproduct from copper ores. Pyrite and sulphur used in the manufacture of sulphuric acid also contain tellurium, as it is found in the flue dust and acid sludge of acid plants. Tellurium minerals are found in Transylvania, Hungary, Spain, Brazil, Bolivia, Chile, Mexico, Japan, Australia, California, Colorado and Virginia.

Efforts have been made by government agencies in co-operation with copper refiners to discover new uses for tellurium, but no important results have been reported. It has been used in a small way in high-resistance and other alloys, in organic dyes, for staining silver, in medicine and as a reagent in chemical laboratories. As a coloring agent in glass or porcelain, blue, brown and red colors may be produced by tellurium, some of the best ceramics being colored in this way. Tellurium dissolved in sodium sulphide solution is used in toning baths for photographic prints. Tellurium dioxide at red heat is a powerful oxidizing agent, decomposing completely even lumps of steel or metal alloys. Its chemical similarity to sulphur suggests many possible uses. It might be used, for instance, as telluride in coloring lithopone, and the extension of the use of tellurium might well be studied in connection with the iron and steel industry. The Bureau of Mines considers there is undoubtedly promise in experimentation with tellurium compounds in the field of organic medicinals, while their physiological action in derivatives similar to those of sulphur and selenium has not yet been developed. In compounds similar to selenium oxychloride, tellurium may provide valuable laboratory reagents.

The use of 0.2 per cent diethyl telluride in gasoline as an anti-knock compound has been reliably reported. It is said to eliminate carbon deposits and to produce greatly increased efficiency when used in motors designed to operate on very high compression. A special type of engine is said to be required to produce these results, hence its general use in motors will not be feasible unless the motor industry should conform to the required type. This step in turn would be dependent on a supply of tellurium adequate to treat all the motor fuel. For this purpose, 1,500 tons of tellurium per year would be required, and as the possible annual supply of tellurium from the present best known sources of copper refineries is said to be only about 125,

000 lb., a much larger supply must be developed; the discovery of new uses not dependent on so large a supply would result in wider utilization of present resources.

Tellurium is usually offered in the impure state, and no market standards have been developed. No ores are known that are rich enough in tellurium to permit mining and treatment for tellurium alone, even if the demand increased to large proportions. It is probable that the future supply will be derived as a byproduct from metallurgical processes, as in the past.

Samples of tellurium for research purposes may be obtained from the Committee on the Uses of Selenium and Tellurium, National Research Council, Washington, D. C.

Comminuted Smokeless Powder for Blasting

Information regarding the physical properties of comminuted smokeless powder and instructions regarding the handling, packing and use of the explosive are given in Serial 2,386, by C. E. Monroe, chief explosives chemist, and Spener P. Howell, explosives engineer, recently issued by the Bureau of Mines.

Tests made by the bureau show that large supplies of smokeless powder left in the possession of the federal government at the close of the war can, in the form of comminuted smokeless powder, be used effectively for certain industrial blasting purposes. Field tests made by the bureau at the explosives experiment station at Bruceton, Pa., have demonstrated the practical value of this powder for stump-blasting, boulder-breaking and ditch-digging purposes. As the result of experiments previously made by the Bureau of Mines looking toward the industrial utilization of other types of military explosives, more than 34,000,000 lb. of surplus trinitrotoluene, 13,000,000 lb. of picric acid and about 1,000,000 lb. of grenade powder have been allotted by the War Department to other departments of the government. These allotments have been used in industrial blasting and also on a great variety of government projects, and gave entire satisfaction.

The problem for smokeless powder is unlike that for TNT and picric acid. Both the latter are detonating explosives used to break up the shell, or other devices containing them, into fragments which act as missiles; smokeless powder is designed to take the place of black gunpowder in driving the projectiles from guns. Hence smokeless powder is a propellant, and an essential of a propellant is that it functions by progressive burning, not by detonation, as detonation within a gun would probably burst the gun.

From the time of the entrance of the United States into the war until its conclusion there was produced in this country 632,504,000 lb. of smokeless powder; at the declaration of the armistice one factory alone of our many factories had a daily capacity for pro-

duction greater than the entire annual capacity of the country prior to the war.

The adaptation of smokeless powder to use as an industrial blasting agent is due to the discovery by Major John Herbert Hunter, Ordnance Department, U. S. A., that when smokeless powder is ground to fineness the ground material can be detonated by No. 6 detonator, and therefore may, in this condition, be used as a blasting agent. Major Hunter has dedicated to public use in the United States the patent granted to him for this discovery. Therefore all are free to use the process without payment of royalty. In his specifications Major Hunter points out that the rate of detonation of this comminuted smokeless powder varies with its fineness as measured by sieves of 8 to 80 mesh; it is possible, then, by regulating the grinding and sieving, to prepare explosives having different but determined rates of detonation, thus suitable for various kinds of blasting. He provides that in use this comminuted smokeless powder shall be packed in cartridges, as is the practice with dynamite. The product is styled "comminuted" because this term is broad enough to include any and every method of subdividing the grains without destroying their chemical identity.

As the gaseous products of detonation include poisonous and flammable carbon monoxide, comminuted smokeless powder is unsuitable for use as an explosive in dusty and gaseous coal mines or in other places where flammable dust, gases or vapors may be encountered. Nor should it be used in mines, tunnels or other close places, unless the ventilation is very good and workmen are not in contact with the poisonous gases produced by it. Comminuted smokeless powder has a pale yellow color with an earthy luster. It is tasteless, odorless and insoluble in water. When touched by the tongue, it gives the sensation imparted by dry earth or chalk. Being insoluble and non-volatile, it is not poisonous, and so far as this characteristic is concerned, it may be handled with impunity. It does not melt when heated, but it is very flammable and easily ignited.

South Carolina White Clays

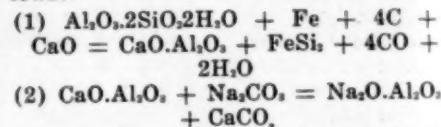
The methods of mining and preparing white clays for market in the vicinity of Langley, S. C., are described in Serial 2,382, by W. M. Weigel, mineral technologist, just issued by the United States Bureau of Mines. Langley is about 9 miles north of Augusta, Ga. The clays mined in this district are sedimentary kaolins with few impurities. The prevailing color is white; at times the color is smoky gray or pink, and occasionally strong pink to lavender. The lighter colors usually become white on exposure to the air and on drying. The lower parts of the beds are usually the whitest. These kaolins are fine grained in texture, and have good plasticity; their tensile strength is from 8 to 36 lb. They generally slake readily. Their specific

gravity is from 2.50 to 2.25. The clays in the district are well adapted for use in paper stock, for which they are mainly used, and in pottery and chinaware, without washing. In the district as a whole considerable reserves of clay are yet untouched, hence the industry can be considered fairly stable.

Copies of Serial 2,382 may be obtained from the Bureau of Mines, Washington, D. C.

Tests on Miguet Process for Obtaining Alumina From Clay

As a good grade of clay contains from 30 to 40 per cent of alumina, the prospect of recovering it is alluring and proposed methods are appearing constantly in the patent literature. Typical of these is U. S. Patent 1,876,563 granted to Paul Miguet. He proposes to prepare an alkaline aluminate by fusing clay, lime and scrap iron with a reducing agent in the electric furnace, the reactions being supposedly as follows:



The sodium aluminate thus obtained readily yields aluminum hydroxide, while the ferrosilicon should be a profitable byproduct.

So many reactions similar to the above have been proposed and it is so popularly believed that alumina can be obtained from clay by fusion that the Northwest Experiment Station of the Bureau of Mines at Seattle, Wash., undertook to investigate the Miguet process. The results are recorded in *Reports of Investigations*, Serial 2,393, by Clyde E. Williams and Clarence E. Simms.

The tests were carried out in a carbon-lined pit furnace of the Girod type, having a tap-hole to remove the fused material. Clay containing 38 per cent alumina, pure air-slaked lime, steel turnings and gas-retort carbon were used. Using these in the proportions indicated by the equations, only a trace of alumina was obtained. Increasing the carbon to three times and the iron to twice theoretical, and melting the charge with the furnace over-powered to such an extent that dense fumes arose, the product was found to contain carbides of calcium, aluminum and silicon, sillimanite and quantities of a glassy substance. Analysis showed that 40 per cent of the silicon had been reduced and alloyed with the iron. About 30 per cent of the alumina was recovered. However, the prospects of successful commercial application are extremely poor, as under the most favorable test the cost of material alone would be more than \$300 per ton. Moreover, there is no proof that calcium aluminate was formed, because with so much carbide present it is just as likely that the sodium aluminate obtained was formed by the decomposition of aluminum carbide and its subsequent solution in the sodium carbonate.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields

Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Economics of Industry Discussed by Engineers

Society of Industrial Engineers Holds Very Successful Convention in New York—Place of Engineer in Business Arouses Interest

JOSEPH W. ROE was re-elected president of the Society of Industrial Engineers at the ninth annual convention held in New York, Oct. 18, 19 and 20. Professor Roe is a member of the executive board of the American Engineering Council and head of the department of industrial engineering at New York University. F. C. Schwedtman, vice-president of the National City Bank of New York, was re-elected treasurer, and George C. Dent of Chicago was continued as secretary and business manager.

"Economics of Industry—the Fundamentals Necessary to Maintain Maximum Production with a Minimum Effort, Waste and Cost" was the major subject of the convention, notable for the wide public interest attracted by the papers and addresses and for the co-operation of the United States Shipping Board, which made the event the occasion for a declaration of policy as to the American Merchant Marine. The report of the American Engineering Council's committee on elimination of waste in industry shaped to a considerable extent the proceedings of the convention, at which the viewpoint of both worker and managing executive was presented.

On the opening day the delegates were luncheon guests of the Shipping Board aboard the steamship President Harding at Hoboken. Commissioner E. C. Plummer of the board made the journey from Washington to address the engineers. Mr. Plummer advocated the passage of the bill providing aid for American ships now before Congress as necessary to economic development and the building up of American trade abroad. "To delay is to play directly into the foreigners' hands," asserted Mr. Plummer.

President Roe, in his opening address, said that "the hard-boiled" factory manager has been forced to accept the pure scientist from the laboratory and that the engineer, the chemist, the metallurgist, as the case may be, is now as accepted and necessary a part of large-scale industry as the accountant.

"We are at another joining of the ways," added Professor Roe. "Fifty years ago it became apparent that industrial waste and mechanical inefficiency were no longer negligible. Today, with the increasing scale of production, it is becoming evident that social wastes are no longer tolerable."

A major cause of overproduction, according to Professor Roe, is the ignoring of the law of diminishing returns by industrial leaders.

ENGINEERS IN BUSINESS

J. H. Pardee, president of the J. G. White Management Corporation, New York, discussing "The Part of Economics in the Formation of a Policy of Business Administration," said that the engineer has presented the broadest and most comprehensive points of view of business practices. Mr. Pardee said manufacturers should have a clearer understanding of the principal characteristics of their business.

Ernest Du Brul, general manager of the National Machine Tool Builders Association, Cincinnati, speaking on "The Economic Aspect of Production," said that the idea that mere fabrication creates value is a common error of industry, continuing:

"In this country we have had various destructive projects by big men in business, like the Ford and Edison and Durant schemes of currency and credit. We likewise have had some notable business smashups, to the tune of three-quarters of a billion of liabilities last year. Heaven only knows how much more was lost by those who did not smash but were able to survive the tidal wave of deflation. The biggest and most failures were among the manufacturers of various kinds, fabricators of goods. Do these failures not indicate that something is very wrong with the economics these men applied in management? Business gets into such a state because business managers start out on false premises due to incomplete knowledge of economic theory."

WELFARE OF WORKERS

Frank B. Gilbreth and L. M. Gilbreth of Montclair, N. J., presented a paper on "The Relation of Fatigue Elimination to Other Activities," which urged that the fatigue committee of the society work along two lines: First, increasing co-operation with others, engaged in other types of work; second, development of units, methods and devices that will be useful in the elimination of unnecessary fatigue.

A feature of the convention was a discussion by William Geiger of Newark, representing the workers, and John A. Faust of New York, representing the executives. Mr. Geiger an-

Activities of British Institute of Metals

A general program of the meetings of the British Institute of Metals and its local sections has been issued by the general secretary, listing a number of prospective papers of considerable importance. The Institute now has five local sections holding monthly meetings during the winter—namely, Sheffield, Scottish (meeting at Glasgow), Birmingham, London and North-East Coast (meeting at Newcastle-on-Tyne). The last has been organized during the summer. Walter Rosenhain, head of the metallurgy department of the National Physical Laboratory, has been chosen to deliver the annual May lecture.

swered the question of executives as to how production costs can be reduced by advising better use of the workers' time. Mr. Faust said that the remedy was to be found in the creation of a commission composed of high-grade specialists in financing, accounting and engineering. This commission, he said, would apply precautionary measures to business much as the Life Extension Institute applies them to the human body.

Robert B. Wolf, of New York, vice-president of the American Society of Mechanical Engineers and a member of the Hoover committee on waste in industry, in an address on "The Importance of the Elimination of Waste to the Economic Structure," said that in order to reduce industrial waste to a minimum industries must be so organized as to stimulate the workers' process of thinking.

MANY PROMINENT SPEAKERS

During the convention sessions were held by various groups, including managing executives, accountants and sales managers. Other speakers at the convention covered a wide range of activities. They included Dr. Lee Galloway, the Ronald Press; Prof. R. C. McCrea, Columbia University; Prof. Fred R. Fairchild, Yale; Prof. Edwin H. Schell, Massachusetts Institute of Technology; Prof. Edward J. Kunze, Pennsylvania State College; Miss Nellie Swartz, New York State Department of Labor; Dr. Louis I. Harris, New York City Department of Health; A. J. Lutterbach, Milwaukee; Charles Cheney, South Manchester, Conn.; O. L. Preble, New York; Dr. Davis R. Dewey, Massachusetts Institute of Technology; Francis H. Sisson, New York banker; Royal R. Keely, New York; Arthur J. Todd, Chicago; Earl B. Morgan, Philadelphia; Miss Louise B. Moore, Poughkeepsie, N. Y.

Grasselli Medal Awarded to W. H. Fulweiler

American Section of Society of Chemical Industry Honors Gas Expert

The Grasselli medal, presented every year by the Grasselli Chemical Co. to the author of the best paper presented before the society during the previous year, was presented to W. H. Fulweiler, chemical engineer of the United Gas Improvement Co. of Philadelphia, at the regular meeting of the section at the Chemists' Club, New York, on Oct. 20. The presentation address was made by H. S. Miner, chief chemist of the Welsbach Co. of Gloucester, N. J.

Dr. Miner sketched the professional career of the medalist and described his numerous accomplishments in the field of applied research in the chemistry of the gas industry. Mr. Fulweiler is a graduate of the University of Pennsylvania and has devoted his entire professional career to the problems of the gas industry, having first served as superintendent of the Kansas City Gas Co., later in the department of tests of the United Gas Improvement Co., becoming chief chemist for that company and finally chemical engineer, the position which he now occupies. He was the first to apply the waste heat boiler in water-gas manufacture. The development of the well known road binder "Ugite" is the result of his research work, as is the "cut-back" method of tar production. During the war Mr. Fulweiler co-operated with the Ordnance Department in developing new processes for the manufacture of toluene. He is also responsible for the development of a new motor fuel for airplanes, which was a byproduct from the manufacture of toluene.

The medalist is well known as the author of many articles and papers on problems and developments of the gas industry.

In accepting the award, Mr. Fulweiler spoke briefly of the growth of the gas industry in this country, pointing out that in spite of the growing popularity of electricity for lighting, the production of gas has increased tremendously in the past 20 years. He expressed the belief that the adoption of the thermal standard starts a new era for the gas industry. He pointed out that the gas industry utilizes some of the most complicated physical and chemical reactions, although very little is known of the fundamental theory back of them. Consequently there is still a big field for research in the gas industry.

The enthusiastic reception which Mr. Fulweiler received was evidence that the choice of this year's medalist was a popular one.

PAPERS ON OZONE

The subject for discussion before the meeting was ozone. Two papers were presented; the first, by F. E. Hartman of the United States Ozone Co., described ozone generators and their industrial application, while the second,

by E. W. Felkel, of Mellon Institute, discussed the effect of ozone on organic compounds.

Mr. Hartman described the early attempts to manufacture on a commercial scale and traced the development of the modern ozone generator. He described the application of ozone to the drying of oils, giving the results of tests comparing the drying of varnish in air and in ozone. It has been established that the physical properties of the varnish are superior when the varnish is dried in ozone; the hardening period is reduced from weeks to hours and some special waterproof varnishes which cannot be satisfactorily dried in the ordinary way can be satisfactorily dried in an atmosphere of ozone. The speaker discussed the effect of ozone on varnish constituents. The action is, in general, both bleaching and oxidizing. Linseed oil is bleached by treatment with ozone. On the other hand, there are some oils that do not bleach on treatment, but after standing for a period of a week following the ozone treatment, they are decolorized. The explanation offered for this phenomenon was that the ozone forms ozonized air which later breaks down and gradually bleaches the oil. No oil has yet been found which cannot be bleached, either by simple treatment with ozone or by such treatment followed by a period during which this secondary action takes place.

EFFECT OF OZONE ON ORGANIC COMPOUNDS

Mr. Felkel's paper described the general behavior of organic compounds when treated with ozone and particularly described the formation and properties of the ozonides. Ozone reacts on organic compounds in two ways: Ordinarily it is an active oxidizer, but with the unsaturated hydrocarbons, it forms addition products.

The formation and properties of the ozonides have been utilized in determining the structure of various organic compounds. For example, the constitution of oleic acid was discovered by first forming the ozonide and then breaking it up.

INDUSTRIAL APPLICATIONS

An interesting discussion of the industrial application of ozone was started by the inquiry of J. C. Olsen, who has worked with ozone in the treatment of contaminated water. Numerous applications were discussed, among which were the use of ozone in the air used for ventilating cold storage warehouses; for the purification of down and feathers and in smoke houses, to prevent the formation of mold on the meat.

Mr. Hartman stated that there are about 1,500 commercial installations of ozone water purification systems in this country. The most widespread application of the apparatus is in the treatment of water used for carbonated beverages. It has also been successfully used for purifying the water in swimming pools.

Technical Meetings to Feature Power Show

Engineering Societies Schedule Meetings to Coincide with Exposition in New York

The National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace in New York from Thursday, Dec. 7 to Dec. 18, closing, however, on the intervening Sunday, is being planned in co-operation with the national societies interested in the economy of fuel and in the production and use of power generated therefrom.

The opening of the exposition in the Grand Central Palace will take place on the closing day of the annual meeting of the American Society of Mechanical Engineers, and time has been set aside in the A.S.M.E. program so that members may attend the opening exercises. Furthermore, the programs of the twenty sessions to be held at the A.S.M.E. meetings have been so arranged that all members attending the meetings may take in both the technical discussions and the exposition in the least possible time.

In addition, the A.S.M.E. professional divisions on aeronautics, ordnance and forest products will hold sessions of general interest to the engineering profession.

The American Society of Refrigerating Engineers is to hold its meeting at the Hotel Astor for three days commencing Dec. 5, and its members, as well as the members of the A.S.M.E., will be admitted to the exposition upon the presentation of their membership cards.

The opportunity this exposition offers for the power house operating man will also be grasped. The National Association of Stationary Engineers is perfecting plans for the various chapters to visit the exposition in a body. In addition, the New York Building Superintendents' Association, 600 strong, will attend in a body and they will be received by the officers of the N.A.S.E.

The great diversity of exhibits insures the particular appeal that this exposition will have to all engineers, as it will permit them to learn quickly and thoroughly of the progress in mechanical engineering. All industries using heat or power in any form will be interested in the displays of steam turbines, steam engines, steam boilers, feedwater heaters, superheaters, economizers, metering devices, stokers, coal handling apparatus, valves and pipe fittings. Each of the exhibitors is planning to emphasize the features of his product which denote progress.

Vitrefrax Company Plant Destroyed by Fire

The plant of the Vitrefrax Company at Los Angeles, Calif., was completely destroyed by fire on Sunday, Oct. 15. Reconstruction was begun at once along lines that will bring the capacity of the plant to a figure considerably higher than ever before.

Federal Coal Commission Begins Study

John Hays Hammond Appointed Chairman of President's Committee to Analyze Problems of Coal Industry

THE FIRST ACT of the United States Coal Commission at its initial meeting on Oct. 18 was to designate John Hays Hammond as its chairman. The commission immediately plunged into a discussion of a program for its exhaustive study of the problems of the coal industry. No formal announcement has been made as to how the work will proceed, but certain of its policies already are apparent. It is the intention of the commission to keep the public informed as to each step of its progress. It recognizes that in this way the public will be able to absorb more knowledge of the problems of the coal industry. The commission recognizes that the only chance that it has to accomplish anything is to obtain public support for its recommendations. It is believed that if the public mind goes through the same processes that the minds of the commissioners will go through, they will be prepared to pass intelligent judgment on the conclusions. Frequently when conclusions constitute the first knowledge that the public has, much time must elapse before their real purport is understood. Thinking takes time. Recognizing that fact, the commission hopes to be able to carry the public along with it as the study progresses.

DISTINGUISHED PERSONNEL

The commission was appointed by the President on Oct. 10. Its personnel includes John Hays Hammond, well-known mining engineer; Thomas R. Marshall, Vice-President during the Wilson Administration; Samuel Alschuler, Judge of Seventh U. S. Circuit Court; Clark Howell, editor of the *Atlanta Constitution*; George Otis Smith, director of the U. S. Geological Survey; Edward T. Devini, teacher, writer and lecturer on social and economic questions and Charles P. Neill, expert on labor problems and conditions.

It is expected that the commission will appoint a fairly large staff of specialists who know how to collect coal information and put it together. It is believed the commission will hold as few formal hearings as possible and try to glean its information through more intimate contact with those who are acquainted with the industry. The hope is very generally expressed that the work will be divided among the individual members of the commission and among the commission's staff so as to amass data in that way rather than go through the time-consuming and generally unprofitable process of a public hearing.

The problem is so intricate that the commission expects to call to its aid each subdivision of the coal industry. One of its first acts was to invite into informal conference John L. Lewis, president of the United Mine Workers of America; Alfred M. Ogle, president

of the National Coal Association, and S. D. Warriner, a leading anthracite operator, and to ask each to appoint a consulting committee, which is to maintain close contact with the commission and assist it by presenting such facts as may be called for from time to time.

IMMEDIATE ACTION EXPECTED

Since E. E. Hunt is the secretary of the commission, it is reasonable to suppose that he will resort to much the same form of organization that functioned so successfully during the President's Unemployment Conference—the plan also used at the Conference on Limitation of Armament. At those conferences, advisory committees, composed of representatives of the varied interests concerned, were used with great success. For instance, an advisory committee on storage would be composed of representatives of coal operators and of large consumers—those most likely to benefit or be interested in storage. This plan, if acceptable to the present commission, would be carried out in a way so that an advisory committee would be formed for each of the important problems within the industry. In this way the commission would be saved a large amount of work and would be furnished with much predigested material.

Since the commission must make its preliminary report on Jan. 15, advantage must be taken of all means to expedite the study. It is probable that the commission will call upon those most concerned to loan it some of their specialists. Only in this way can the commission secure the requisite skill necessary to its work.

Daugherty Makes Capital of Chemical Foundation Suit

In a campaign speech at Canton, Ohio, on Oct. 21 Harry M. Daugherty, the Attorney-General, among other things said:

"We would have heard little criticism of the Department of Justice had it not been discovered that a case like the Chemical Foundation, for instance—in which valuable patents were assigned by public officials to companies which they themselves had organized—was under investigation, and the part played by those involved also was being scrutinized by government agents.

"And let me here, without giving any intimation as to who the men were, let me suggest that I have had the unique experience of sitting in the Department of Justice and listening to the story of a man formerly connected with the government and hearing patiently his pleas for certain fairly legitimate concessions, when, at the same time, in the city of New York, another former official, one of his associates, was busily engaged in getting contributions and

making connections in order that the attacks upon the Department of Justice and the government might be increased, reinforced and successfully continued.

"I can give the names of these parties if ever they lift their voices to dispute this statement, but, unless I am authorized by them so to do, I should like to go through this entire investigation without prematurely mentioning names except in the orderly process of court proceedings. Their names, however, will be found in connection with certain litigation wherein some of the most important questions and some of the most questionable transactions and some of the most valuable properties in the world are in dispute, and the right and wrong of the transactions connected with the transfer of certain property must be determined in a court of justice."

Gas Analysis Basis for Automatic Control

Washington Chemical Society Has Demonstration of Novel Principle for Process Control

A most convincing demonstration of the manifold possibilities of automatic gas analysis for industrial process control was given by P. E. Palmer of the Bureau of Standards on Oct. 12 before the Chemical Society of Washington. Mr. Palmer illustrated a number of the automatic methods of analysis of gas mixture met commonly in industrial work and showed how the analytical apparatus could be made to control automatically the composition of these gases within narrow limits.

One of the most striking examples demonstrated was in the case of a mixture of sulphur dioxide, carbon dioxide, hydrogen and air. Three gas analysis cells were used in this apparatus, the first indicating or controlling the sulphur dioxide concentration, the second the carbon dioxide concentration, and the third the hydrogen concentration in the mixture. An automatic continuous record can be made of the percentages found.

The operation of the apparatus depends upon the difference in heat conductivity of the gas mixture and the same gas after removal of the constituent to be determined. Thus, in the case of sulphur dioxide the heat conductivity of a mixture containing it is compared with the heat conductivity of the same gas after passage through an iodine solution to remove the sulphur dioxide. In cases where it is not feasible to remove the constituent by any simple chemical method, the unknown gas may be compared with a known standard gas, and if pains be taken to maintain operating conditions properly, equally reliable results are obtained by this method.

The apparatus has been given successful test in a number of plants for long periods. Many interesting possibilities for further application have been suggested.

Dirigible Accident Hastens Helium Development

Destruction of C-2 Emphasizes Need for Improved Recovery Processes and Federal Action

As a result of the destruction of the dirigible C-2, the possibility is admitted at the War Department that no further use of hydrogen will be made in the inflation of ships of the dirigible type. There is enough helium available at present to inflate three ships of the C-2 type. The Fort Worth helium plant is again in operation, thus promising material additions to the present reserve. While the recovery of helium in that plant is costly, an effort is being made to increase the present reserve from 2,500,000 to 10,000,000 cu.ft. The gas from the Petrolia Field, which is comparatively rich in helium, is being burned, with the prospect that this unusually favorable source of supply soon will be gone.

Because of the great expense attached to the recovery of helium at present, it may be that practice with dirigibles will be discontinued until greater reserves are built up and cheaper methods of recovery devised. While the use of helium greatly reduces the fire hazard, it cannot be eliminated, since a gasoline load must be carried to operate the engines. Disaster can come in other forms to such craft, so it is doubtful if either the army or navy would be willing to risk any great amount of practice flying when an accident would mean the loss of one-third of the helium available.

HOPE TO IMPROVE PROCESS

Experiments conducted by the Bureau of Mines in its cryogenic laboratory have been so successful that a plant of semi-commercial size is to be built to demonstrate whether or not the laboratory method will work out on a larger scale. That plant will be in operation during the present fiscal year. Those who have followed these experiments are hopeful that a great reduction in the cost of recovery will be found possible.

Before any extensive use of dirigibles inflated with helium is attempted, it is probable that the ships will be redesigned. This can be done so as to result in considerable efficiencies. It will be possible to place the engines very close to the envelope, thereby greatly increasing their efficiency and making possible greater ease in the manipulation of the craft. There is every reason to believe that the fire hazard can be reduced until it is no greater than in the case of airplanes.

ACCIDENT WILL HASTEN ACTION

The accident to the C-2 is certain to stimulate the consideration of the helium bill now before Congress. Hearings on this measure are to begin in November or December. This bill has received the approval of the President and of several members of the Cabinet. It proposes to centralize in the Bureau of Mines all matters pertaining to the

Committee to Investigate Direct Oxidation Method of Sewage Disposal

Following the reading of a paper before the American Public Health Association in Cleveland, Oct. 19, by G. W. Fuller on "Sewage Disposal at Lima, Ohio," discussion centered on the so-called "direct oxidation process." This is the method formerly known as the Landreth electrolytic lime method which had previously received attention of engineers and sanitarians following investigations and experiments at Elmhurst, N. Y.; Decatur, Ill.; Phillipsburg, N. J., and Allentown, Pa.

The Sanitary Engineering Section of the A.P.H.A. decided to appoint a committee to investigate the efficacy of this process and to make its report at the next annual meeting of the association. In addition to members of the Sanitary Engineering Section, this committee is to include a representative of the American Electrochemical Society.

conservation and production of helium. The army and navy is to be given first call on any supplies developed. The bill provides a revolving fund of \$5,000,000, of which a part can be used for the construction of a plant, the purchase of leases and in the conservation of existing supplies. The remainder is to be used as an operating fund. The helium produced is to be turned over to the army and the navy, which are to reimburse the revolving fund. Any surplus not needed for military purposes can be sold or leased for commercial use. The bill also prohibits the export of any helium.

The President is on record as favoring this legislation. Before the bill was sent to Congress, the Secretary of the Interior took the matter up with the President. In that connection the President wrote Secretary Fall:

I have received a copy of the proposed bill authorizing the conservation, production and exploitation of helium gas, which you recently sent me.

I note that the Secretary of War and the Secretary of the Navy, as well as yourself, strongly approve this bill. I agree with you that the matter in question is of great importance and that Congress should make provision for obtaining a proper supply of helium for the future needs of the army and navy. Conditions for extracting the gas at a reasonable cost should also be made as favorable as possible. Since this country has practically a monopoly of helium resources at the present time, it would appear to be advisable to hold this monopoly and exercise control over exportation of the gas. I believe that the bill in question covers these points and I therefore suggest that you transmit it to the Military Committee of the House and of the Senate with a recommendation for its early consideration.

Helium occurs in the gas of a number of American fields. It is estimated that enough of it is going to waste each day to fill a dirigible the size of the ZR-2. An indication that the recovery of helium at a cost which is not prohibitive is not regarded as improbable is the fact that rights to construct zeppelins in this country have been obtained and construction is now in progress. These interests are considering the production and use of helium.

German Reparation Dyestuff Deliveries

Bulk of Them Made Right After the Armistice—Italy Has Received the Most

Contrary to the popular conception that Germany reparation deliveries of dyestuffs have been made in large proportion since the London schedule of payments, a study of the records by the Western European Division of the Department of Commerce shows that the major deliveries were made during the months following the armistice, in the first efforts of Germany to meet the requirements of the Versailles treaty. The London schedule of payments became effective on May 1, 1921.

Distribution of the deliveries made previous to May 1, 1921, was as follows:

	Gold Marks
France	9,251,000
Italy	9,124,000
British Empire	8,499,000
Belgium	2,949,000
Japan	2,630,000
Serb-Croate-Slovène State	23,000
	32,476,000

On May 1, 1921, Germany began deliveries on account of the annuities described in the schedule of payments and dyestuff deliveries are now credited to annuity payments only. From that date to June 30, 1922, they totaled 10,708,000 gold marks distributed as follows:

	Gold Marks
Italy	5,589,000
Belgium	3,221,000
France	2,006,000
British Empire	1,696,000
Greece	196,000
	10,708,000

Thus during the 31 months previous to the London schedule the deliveries were 75.2 per cent of her total deliveries, leaving 24.8 per cent during the 14 months since that schedule became effective.

An interesting fact which appears in the records of deliveries is that the largest deliveries have been to Italy, rather than to France and Belgium, as popularly believed. Deliveries to France were one million gold marks less than to Italy, while those to Belgium were less than half as great as to Italy. The total distribution to June 30, 1922, was as follows:

	Gold Marks	Percentage
Italy	12,213,000	29.4
France	11,257,000	26.0
British Empire	10,195,000	23.6
Belgium	6,170,000	14.3
Japan	2,630,000	6.1
Greece	196,000	.5
Serb-Croate-Slovène State	23,000	.1
	43,184,000	100.0

The above tables include only the deliveries distributed among the powers. In addition to these, from the beginning of German deliveries to June 30, 1922, dyestuffs to the value of 4,000,000 gold marks were sold through the Reparation Commission to the Textile Alliance of the United States and others to the value of 3,000,000 gold marks were resold to German buyers. These sums were credited as cash received rather than as deliveries in kind.

Engineers Discuss Scientific Management

Many Joint Meetings of Three Societies Feature "Management Week" in Various Cities

Management Week meetings, bringing forcibly to public attention the increasing importance of the engineer in industry, were held in thirty cities, Oct. 16 to 21, under the auspices of the American Society of Mechanical Engineers, the Society of Industrial Engineers and the Taylor Society. With these societies, other engineering organizations and civic and economic bodies co-operated.

President Dexter S. Kimball and Vice-President L. P. Alford were among the principal speakers. Dean Kimball addressed the Central Pennsylvania local section on Oct. 16, the Cincinnati section on Oct. 19, and the Columbus section on Oct. 20. Mr. Alford spoke at Meriden, Conn., on Oct. 16; at New York on Oct. 17, and at Plainfield, N. J., on Oct. 18. A meeting at St. Louis on Oct. 11 was addressed by John Lyle Harrington of Kansas City, president-elect of the A.S.M.E.

Mr. Alford's paper, entitled "Ten Years Progress in Management," was read at meetings in several cities, including Birmingham, Ala., Davenport, Ia., and Chicago. Mr. Alford elaborately reviewed the history of the advance of scientific management. "Industry and business as developed in modern civilization must continue, else infinite misery will overtake the human race," said Mr. Alford. "Management is the agency by which community, state and nation shall endure."

ENGINEERS IN MANAGEMENT

Messages presenting the American, the English and the German points of view were read at meetings throughout the country. Dean Kimball, speaking for the American engineer on the question of management, said:

"The engineer has been drawn into the field of management partly because of his proximity to the problems of industry, partly because of the exigencies caused by the rapid growth of scientific methods, but more particularly because of his scientific method of attacking problems of all kinds. It has been found that his methods of attacking the problems of design and construction are powerful tools in handling the problems of administration. There can be little doubt that the engineering executive is to remain a dominant figure in industrial management. I do not contend that he alone can solve these human problems, but I do believe that if he will give his best effort to this work he can make a contribution that will go a long way toward the attainment of industrial peace."

MESSAGES FROM ABROAD

James F. Whiteford, discussing "Development of Management in the United Kingdom," said: "In general, it may be stated that management practices in

the United Kingdom are following very closely the same sequence of developments as have been instituted in American industries. The application over there is a few years late, but the best portion of the practices in American industries is being fairly generally accepted over there."

G. Schlesinger of Charlottenburg, Germany, told of "The Development of Scientific Industrial Organization in Germany," saying: "It gives me pleasure to be able to place before the American industrial world some proofs of successful results in scientific and practical industrial organization in Germany. I am convinced that after a long period of 'lagging behind' we have at least caught up with the Americans in scientific management; but the deeper foundation that we possess and the greater economy in the manipulation of our system (we can carry out the work of accounting in factories according to our method with half the personnel that is required with the usual American system) will perhaps prompt American industry to take note of our organization science and practice, as the German industry once gladly and gratefully accepted advice and information from American sources."

NEW YORK MEETINGS

Conspicuous among the Management Week meetings were those held in New York, Chicago, Indianapolis and Cambridge, Mass. Fred J. Miller presided at the New York meeting, speaking generally on the results attained by scientific management and on its potentialities. Other New York speakers were Myron H. Clark, of the United States Rubber Co., John H. Williams of Philadelphia and Frank B. Gilbreth of Montclair, N. J.

MEETINGS IN VARIOUS CITIES

Three meetings were held in Chicago at the Auditorium Hotel, the keynote being "true wealth and prosperity come only from careful, unwasteful management of productive enterprises, coupled with industry and thrift." The Boston Engineering Societies participated in the Cambridge meeting held at Harvard University. Other co-operating organizations were Boston Chamber of Commerce, Associated Industries of Massachusetts, Taylor Society, Society of Industrial Engineers, Boston Association of Stock Exchange Firms, Massachusetts Bankers Association and Harvard Graduate School of Business Administration.

Management mechanisms and their efficiency is one vital subject which the industrial engineer studies. Stores control, standardization of operation, cost accounting, educating the employee, scheduling and planning are all management mechanisms. Human engineering is an elaborate title for the vital work being done on employee-employer relations and throughout all their work must be the leaven of service and an emphasis on the service motive—a real industrial co-operation which is the only basis for ultimate industrial health.

Potash Producers Must Work Own Salvation

"Desperate but Not Hopeless," Says Association Secretary

The domestic potash industry has been dealt a severe blow by failure to protect it from foreign competition in the new tariff act, but by careful management and reductions in costs it will survive and eventually develop health, in the opinion of Frederick W. Brown, secretary of the United States Potash Producers Association.

Reports show that the Nebraska field is completely out of production. The Nebraska output, while low in salt content, formerly supplied approximately half of the United States tonnage. The only activity in Nebraska at present is by one company which is sinking a well in hope of striking either oil or gas which would give cheap fuel and permit operation.

There are only three companies in general commercial operation for potash now, in contrast to the high record of 77, exclusive of wood-ash producers, in 1918, this figure declining to 18 in 1921. These three are the American Trona Corporation of Searles Lake, Calif., with potash deposits, and two byproduct plants, that of the Santa Cruz Portland Cement Co. of San Francisco, which produces from cement mill dust, and the United States Industrial Chemical Co. of Baltimore, producing from alcohol distillery waste. There are two, possible three, other cement plants which are selling dust locally, to farmers who bring their wagons to the plants.

While production is far below the war records, the potash now being produced is of very much higher grade on the average than the war-time average. Despite conditions in the domestic industry, potash men are pushing ahead to develop their business in hopes of eventually being able to meet the German and French competition, probably by a combination of an increase in the price of the foreign product and a lowering of their own costs.

The core drill being sunk in west Texas to determine the stratum of the potash deposits known to exist over a wide section of that country is reported to be down about 900 ft. This potash is known to be comparable to the best German potash.

Mr. Brown expects a combination of the French and German potash interests and a considerable increase in their prices this year. The condition of the domestic industry is summed up by Mr. Brown in the phrase, "desperate, but not hopeless."

Feldspar Producers Contemplate Organization

Feldspar producers throughout the country have been invited to gather in Washington on October 25, to determine whether or not to form a national association. The meeting will be held in the director's office of the Bureau of Mines, at 11 o'clock a.m.

Personal

CHARLES T. BRAGG, formerly with the Michigan Smelting & Refining Co., is now president and general manager of the Michigan Valve & Foundry Co.

DR. FRANK K. CAMERON, general manager of the Salt Lake Insecticide Co., Salt Lake City, Utah, gave an interesting address at a recent meeting of the mining committee of the local Commercial Club, dealing with the conversion of the scorodite ores of the Western Utah Copper Co. into calcium arsenate.

FRED W. COHEN, assistant general manager of the Metal & Thermit Corporation, has gone to Europe for an extended business trip.

J. V. N. DORR returned a few weeks ago from a 6 months' trip to England, France and Germany, where he inspected numerous installations of his machinery in the metallurgical and chemical plants of those countries.

FRANK HODSON, president of the Electric Furnace Construction Co., has just returned from a trip to Europe, having been gone several weeks.

E. J. JANITZKY has been awarded the gold medal for the best paper presented before the annual meeting of the American Society for Steel Treating, held a year ago at Indianapolis. His paper "Influence of Mass in Heat Treatment" was reprinted in *Chemical & Metallurgical Engineering*, vol. 25, page 783. The second prize was awarded to Messrs. Gill and Bowman for a paper on the "Constitution of High-Speed Tool Steel."

H. A. LINCH, director of the Westport Mill, has begun an inspection of the beet sugar industry both in this country and abroad.

W. E. McCORMICK has been appointed development engineer at the tire and tube departments of the Youngstown, Ohio, plant of the Republic Rubber Corporation. E. A. Armstrong has been made general superintendent at the plant.

WALTER S. MCKEE has resigned as vice-president and director of the American Manganese Steel Co. and will develop the business of the Inland Engineering Co. of Chicago, of which he is president.

DR. GEORGE OTIS SMITH has been appointed a member of the President's Coal Commission, which will make it necessary for him to reduce his duties as director of the U. S. Geological Survey. P. S. SMITH will act as director during the time that the Coal Commission will require the major portion of Dr. Smith's time.

F. B. TOUGH, United States supervisor of oil and gas operations on leased public lands, has been appointed chief petroleum technologist of the Bureau of Mines, to succeed A. W. Ambrose.

The president of the American Electrochemical Society has appointed an advisory committee to co-operate with

the Bureau of Mines in its electrometallurgical work. The committee is constituted as follows: Cari G. Schluederberg, Westinghouse Electric & Manufacturing Co.; Acheson Smith, Acheson Graphite Co.; Frank W. Brooke, Electric Furnace Construction Co.; Daniel L. Crosby, Detroit Electric Furnace Co.; C. B. Gibson, Westinghouse Electric & Manufacturing Co.; John A. Seede, General Electric Co.; Robert Turnbull, U. S. Ferro Alloys Co.; F. A. J. Fitzgerald, consulting metallurgist, Niagara Falls.

The American Mining Congress elected the following officers at the twenty-fifth annual convention of the organization recently held in Cleveland: President: Sidney J. Jennings, vice-president, U. S. Smelting & Refining Co., New York City. Directors: Daniel B. Wentz (re-elected), Philadelphia, Wentz Coal Corporation; William Lindsay, Napier Iron Works, Nashville, Tenn.; W. C. Doering, Southern Wheel Co., St. Louis; Albert Nason, Nason Coal Co., Chicago, Illinois. Vice-presidents: Daniel B. Wentz; H. W. Seaman, Chicago; E. L. Doheny, Mexican Petroleum Co., New York.

& Northwestern, Illinois Central and several other railroad companies to study railway economics in Europe.

Upon his return from Europe in 1889, Mr. Washburn played an important part in the development of Purdy's dam and reservoir and other sources of New York City's water supply. Later he went to Chile as consulting engineer in connection with the production and shipment of Chile's nitrate of soda. His next important work was as consulting engineer in connection with the building of an interoceanic canal in Central America, a project which was abandoned when the United States Government undertook the building of the Panama Canal.

After some years spent in developing coal and iron mining and water-power projects in the South, Mr. Washburn saw the possibilities of application of hydro-electric power to the fixation of air nitrogen for the manufacture of fertilizers. The result was the organization of the American Cyanamid Co. Factories were erected at Niagara Falls, on the Canadian side, which since have developed an annual production of cyanamid for fertilizer and chemical use valued at more than \$10,000,000.

Before the war, Mr. Washburn foresaw that if the Chilean supply of nitrate of soda upon which the United States depended for making military explosives were cut off, this country would be seriously menaced. As early as 1910 he gave his thought to a means of making America independent of South American deposits so that in the event of an enemy blockade the country could produce its own nitric acid. The German Government had already started on a large scale, for military purposes, the same fixation of air nitrogen which Mr. Washburn and his associates had applied to agriculture.

So with the entrance of America into the World War, Mr. Washburn and the American Cyanamid Co. were requested by the Ordnance Department to organize the Air Nitrates Corporation to construct and operate for the government the huge \$50,000,000 air nitrates plant at Muscle Shoals, Ala. Mr. Washburn was the president of the corporation. Although the armistice came before the Muscle Shoals plant and two others near Cincinnati and Toledo were completed, this great war project is one of the few that could be turned to peace time use.

Mr. Washburn was president of the Goodman Manufacturing Co. of Chicago. He was married in 1890 to Miss Irene Russell of Augusta, Ga., a member of an old and prominent Southern family. He was a trustee of Cornell University for two terms and also of Vanderbilt University. He was a member of the American Society of Civil Engineers, American Institute of Mining Engineers, Society of Western Engineers, American Institute of Electrical Engineers, American Electrochemical Society, Alpha Delta Phi and Sigma Xi, the honorary scientific society. Among his clubs were the University, the Apawamis and the Century.

Obituary

FRANK SHERMAN WASHBURN, chairman of the board of directors of the American Cyanamid Co., whose death on Oct. 9 was briefly noted in these columns last week, was a pioneer in the development of the process of extracting nitrogen from the air. He was born in Centralia, Ill., Dec. 8, 1860, the son of Elmer Washburn, a former president of the National Livestock Bank of Chicago. He was graduated as a civil engineer from Cornell in 1883 and became associated with railroad engineering in the Middle West. He reorganized the belt line of the Union Stock Yard & Transit Co. and then was sent abroad by the Chicago



FRANK SHERMAN WASHBURN

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

A Persistent Shortage of Unskilled Labor

A Great Decrease in Immigration Is Partly Responsible for This Shortage—How Extensive Will It Become? Will It Effect a Change in the Manufacturer's Attitude Toward Labor?

UNSKILLED LABOR is an essential to chemical industries. In fact, the proportion of skilled labor, in the ordinary sense of the word, to unskilled labor in chemical plants is exceedingly small. Unlike the mechanical industries, the proportion which labor cost represents of the total cost of a product is small. All generalizations on this subject are somewhat unsafe, but 15 per cent might be said to represent as close an estimate as possible. Labor problems in chemical industries, since they represent only 15 per cent of the total cost, and since this labor is largely unskilled, have never held a predominant position in the minds of chemical executives. Nevertheless the labor shortage during wartime brought home to chemical companies the necessity of having a supply of such labor as is needed and brought it home hard. There followed the period

of prosperity in 1920 during which time the returning soldiers and workers in war-time industries eliminated the labor problem. In 1921 manufacturers began to forget that there ever was a labor problem, for there was always a large supply of workmen waiting at the factory gates for an opportunity to work. And then when they had completely forgotten the problem it loomed up again, especially in industries analogous to the chemical industries wherein unskilled labor is in demand. The first important notice which was taken of this shortage was when the U. S. Steel Corporation advanced common labor wage 20 per cent, and now it is a common cry that unskilled labor is not to be had.

A search into the reasons for this shortage is worth while in order to determine the probable extent of the shortage and whether any remedies suggest themselves. Service letter No. 123 of the National Industrial Conference Board of July 3, 1922, discussed the labor shortage at some length, mentioning the many localities which had already felt the shortage and the time when the shortage began to appear;

decrease unless a radical change in the national policy toward immigration takes place. The immediate effect of this situation will be a scurry by manufacturers to enlist the aid of nostrums and formulas designed to "solve" all labor troubles. For example, many firms will take out life insurance for the benefit of its employees and profit-sharing schemes will come into being by the gross. All of this will be a frantic gesture on the part of managements to retain their common labor. It will largely be unsuccessful, for the laborer can sense with uncanny accuracy the spirit which moves management and will recognize such gestures as the above in their true light

—a primarily selfish motive. The answer will have to be a complete change of attitude. From neglect of labor problems and temporary palliative, management will have to adopt constructive measures, an attitude which begins with a sound philosophy of labor's share in manufacturing enterprises and which is synthesized with a true sense of justice toward labor.

There are enough successes as a result of this attitude to warrant adherence to it. "A word to the wise is sufficient!"

When an Irresistible Force Meets an Immovable Body

The irresistible force in this specific instance of the proverb is American productive capacity and energy. The immovable body is economic law. For a long time we have been a debtor nation and our trade balance, the ratio of exports to imports, has been favorable—that is, greater than 1. Now we are a creditor nation, and economic law states that our balance of trade must become unfavorable—that is, that imports must be greater than exports. Does this mean that our productive capacity, if it does not actually fall off, will at least not keep pace with its expected increase and with the increase which would normally be expected from the survey of the past half century? This increase up to the present time has been the most amazing industrial development ever recorded and it actually takes on the proportions of an irresistible force.

Before we enter cyclone cellars to await the crash, we might consider the words

which Secretary Hoover advanced in his Toledo speech on this subject. Certain unique factors enter into any settlement of international balances between Europe and America, such as the annual expenditure of American tourists abroad, the remittances of immigrants in the United States to their relatives abroad, the growing volume of investments made by Americans in foreign countries, interest upon investments in the United States of private citizens of debtor countries and such other items as are usually called invisible exchange. This invisible exchange was estimated to be one and a half million dollars in the last fiscal year, a year of depression. It is likely to increase, so it is perhaps possible that American productive capacity may still maintain a favorable balance of trade, even though we are a creditor nation. There is at least food for thought. There usually is in anything Herbert Hoover has to say.

then it went on to point out that under the present immigration act only one-tenth the net increase in population due to immigration was recorded in 1921 as against the pre-war rate. In the year ended June 30, 1922, 309,556 men, women and children were admitted to this country, whereas 198,712 left the country. This is a net gain of 110,000 persons, yet when we come to study the classifications of these people we find only 32,724 laborers among the immigrants and over 100,000 emigrating. This amounts to a net loss of 67,334 laborers, and it is on this class of labor that chemical industries must depend, a significant loss that demands immediate executive attention.

So we are faced with a shortage which is likely to increase rather than

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14	
This week	157.71
Last week	153.77
October, 1921	151
October, 1920	263
April, 1918 (high)	286
April, 1921 (low)	140

Only one of the commodities declined in price during the last week, ammonium sulphate, and that very slightly. The relatively large increase in the index number is due to increases in the prices of commercial solvents, particularly methanol, and also of linseed oil, both of which are important factors in the index calculation.

Price Fluctuations and the "Reasons" for Them

Every now and then it is desirable to dip behind the scenes and evaluate the reasons given for the rise and decline of the market price of commodities. A commodity is advanced in price. Consumers as well as economists and students of markets ask: Why? Frequently the answer is "increased cost of production," and occasionally this answer may be correct. On the other hand, it must be remembered that unless the market is strong and the demand vigorous, an increased cost of production would not, could not, affect the selling price. Let us take, for example, the increased price quoted on commercial solvents during the past week. It so happens that the shortage of common labor, already referred to, has very definitely increased the cost of manufacturing these products. Lumbering was one of the first industries affected by the labor shortage. On the other hand, this effect has been felt in the industry for some months and yet from February until the end of September there was no change in quoted prices and some contracts most advantageous to the consumer were made at prices well under market quotations. In September the demand began to stiffen, perhaps because excess stocks had been used up, and within a month the price increase has been 25 cents per gallon. In other words, the increase in selling price lagged behind the increase in manufacturing cost probably by months.

CHEMICAL MARKET IS SPECULATIVE

Thus to give as a reason for the increase in selling price the increased cost of production is not a fair statement of the case. In other words, the formal reasons given for price increase must be discounted. The real reasons or the immediate reasons for most price changes can be traced to the speculative nature of the market. This situation is inevitable when a commodity market is handled through brokers, dealers and selling agents. Their big profits (and big losses too) are derived from fluctuating markets, and the tendency is therefore to develop a speculative market. The effect of this upon manufacturers depends upon the proportion of their business which is handled in this way. Large fluctuations in price are apt to be very dangerous to producers, although it must not be supposed that some of them do not welcome a fluctuating market.

THE MIDDLEMAN'S WINGS AND HALO

This must not be construed to be an indictment of the middleman. It happens to be the Mr. Hyde side of him and it is on the whole an unbalancing and therefore detrimental influence to the industry. There are plenty of reasons why the middleman is a Dr. Jekyll to this industry as well as all industries. He needs no defense. If he were nothing more than a sensitive barometer, he would fill a valuable function.

The St. Louis Market

ST. LOUIS, Oct. 19, 1922.

The market for industrial chemicals has now settled down considerably after a very exciting period brought about by the new tariff. However, inquiries are still very heavy and actual buying is being continued in large volume. Nearly all orders received are for immediate shipment, as buyers are encountering more difficulties each day with transportation facilities, and furthermore, many large consumers wish to cover their winter requirements of certain commodities at this time of the year. There have been no important price changes since our last report, and apparently domestic producers have about adjusted their prices to meet the foreign competition. In view of the transportation difficulties and the shortage of stocks created by the sudden demand of several weeks ago, buyers should anticipate their requirements very liberally until the freight movement becomes easier and production again normal.

ALKALIS

Only routine business is being transacted in the alkali market at present and prices remain as they have been for the past 60 days. Not much of a change either way is expected, for some time to come. *Caustic soda solid* is being quoted in 5-drum lots at \$3.85 per 100 lb. delivered buyer's door, with a 55c. differential for the flake. Plenty of stock on consignment in this market. *Soda ash*, 58 per cent light, is quoted at \$2.20 in bags and \$2.40 in barrels for 5 to 10 barrels or bags. *Bicarbonate of soda* is being passed along at \$2.40 per 100 lb. generally, although in a few cases this has been shaded to \$2.25. *Sal soda* can be had generally at the buyer's price, barrels having gone as low as \$1.65 per 100 lb., with kegs at \$1.90.

GENERAL AND SPECIAL CHEMICALS

The heavy mineral acids are moving in large volume and the demand is increasing. Prices are quite firm and stocks very limited. *Acid carbolic crystals* is moving very freely and in large volume at the present prices. While the demand for *citric acid* is only routine, the tight situation which has existed for some time is still in evidence and spot stocks are extremely light. Domestic producers are still unable to bring up their production to meet the demand from the regular trade. Prices are very firm. There is no heavy demand for *tartaric acid* at this moment, but sales of large volume are being made through regular channels. The demand for *phosphoric acid sirupy* is nil. *Aqua ammonia*, 26 deg., has firmed up a bit, but the demand is only routine. The *white arsenic* market has advanced very sharply since our last report and is now being quoted at 9½@10c. New York, with practically no stocks available. Some domestic producers are sold up entirely and their output is insufficient to take care of their regular trade. *Carbon bisulphide*

has slowed up a bit and spot goods are easily obtainable. The *copperas* situation is still unchanged, the demand greatly exceeding the supply. Prices are quoted at \$20@\$21 per ton in bulk f.o.b. producers' works. *Glycerine* is holding firm at 18½c. in drums and a further rise in price might make its appearance in the near future. *Sulphur* is still being quoted at the very low figure of \$1.90 per 100 lb. for the commercial flowers, and we judge that the fight between the producers is still on, since this is abnormally low for sulphur. *Zinc dust* has advanced sharply and is now being quoted at 10c. in carload lots f.o.b. New York. In our last report we intimated that an advance in *zinc sulphate* should be expected at any time, and today carload lots are being quoted at 3½c. f.o.b. St. Louis; less than carload lots at 3½c. f.o.b. St. Louis, showing an increase of ½c. A still further advance may be expected at any time. Stocks in the hands of producers are only fair.

VEGETABLE OILS AND NAVAL STORES

Turpentine is climbing steadily upward and it seems that the end is not yet. Today's market quotes turps in 5-bbl. lots at \$1.60 and single barrels at \$1.66 per gal., which is a jump of 10c. per gal. over yesterday. *Castor oil* is firm at 14c. in drums, with no indication of a price decline. Sales are better than normal. *Linseed oil* is moving in good volume and quite a bit of contract business, in some cases coming to May 1, is being done. Spot prices in 5-bbl. lots are 90c. for raw; 92c. for boiled, while single barrels are held at \$1 for raw; \$1.02 for boiled.

The New York Market

NEW YORK, Oct. 23, 1922.

Domestic inquiry has shown material improvement during the past week, especially for the more important basic commodities. Importers, however, were eager to dispose of some surplus stocks of lesser items and slight shading of quotations resulted. The demand for bleaching powder, caustic soda and soda ash was maintained and considerable business was transacted for home consumption. The most noteworthy feature of the week's activities was the acute advance in all solvents. Manufacturers announced advances in acetone, acetate of lime, formaldehyde and methanol, due to increased costs of production. Formaldehyde showed the most strength, with spot supplies very limited and demand strong. Commercial white arsenic retained its past strength and distributors were again inclined to raise prices. Prussiate of soda, barium carbonate and chloride, permanganate of potash and sal ammoniac showed slight reductions, due to a desire on the part of several smaller importers to dispose of surplus stocks. Citric and tartaric acids were in good demand and a fair volume of business was transacted. Acetic and sulphuric acids were quite firm, with the former quoted at slightly higher

levels, due to the advance on all acetate products.

GENERAL AND SPECIAL CHEMICALS

Alums—Important producers and dealers are quoting 3½c. per lb. for the ammonia lump in quantity lots. Sales of the potash alum are recorded at 3½c. per lb.

Acetate of Lime—Producers have announced another advance and the present market is being held around \$3 per 100 lb. in bags. The new price is said to be due primarily to increased costs of production. Demand is quite active.

Acetone—A new advance due to increased costs of production is reported and a more pronounced demand is evident. The new figure ranges around 22½c. per lb.

Arsenic—Manufacturers are now quoting as high as 10½c. per lb. for prime white powdered material on spot. Supplies are very limited for immediate delivery and demand continues quite active. Futures are quoted at 10@10½c. per lb.

Barium Carbonate—Spot material is obtainable at \$75 per ton. Several large tonnage sales were reported at this figure. The general range is around \$75@\$80 per ton.

Bleaching Powder—Leading producers quote 2c. per lb., f.o.b. works for carload quantities and report an active demand. Shipments over the remainder of the year are held at the same price.

Caustic Soda—The export demand is moderate at \$3.45@\$3.50 per 100 lb., f.a.s., standard brands. Dealers report a very good movement for domestic consumption at \$3.75@\$4 for 100 lb., ex-store New York. A heavy demand is reported on contract, with producers quoting \$2.50 per 100 lb., basis 60 per cent f.o.b. works.

Formaldehyde—Makers announced an advance to 13½c. per lb., f.o.b. works in carload lots. On account of the advance in methanol, producing costs have increased and this is maintaining a strong market for the product.

Sal Ammoniac—Imported white granular is somewhat easier on spot at 6½c. per lb. The gray variety is very scarce and some sellers are asking up to 8½c. per lb. The general tone is fair.

Methanol—Producers have sharply advanced prices and the market was exceedingly active, with production in most instances well sold ahead. Quotations for the 95 per cent were heard around 90@92c. per gal. The 97 per cent was quoted at 92@94c. per gal. Denatured and ethyl alcohol remained unchanged.

COAL-TAR PRODUCTS

The general condition of the market maintained a steady tone in most of the crude products and intermediates. Business continued moderately active, with no depressing tendencies noted. Inquiries from consumers are reaching the market in fair amount and indications point to a gradual increase in the volume of business. Phenol still con-

tinued to be the feature of the market, with supplies exceedingly scarce. H acid was advanced by several leading sellers. Orthonitrotoluene was also quoted higher, with the demand quite active.

Aniline Oil—An active demand for this material is holding the market steady at 16c. per lb. Several interests recorded some fair-sized tonnage transactions at this level. Smaller lots were quoted at 17c. per pound.

Alpha-naphthylamine—Producers are placing a fair business at 29c. per lb. and report a very steady market. The general range is around 29@30c. per pound.

H Acid—Producers quote much higher prices for this product and while resale lots can be had at slight concessions, the general tone is much firmer at 85@90c. per pound.

Phenol—A very strong demand continues to feature this market. Offerings are very limited and available material is being held at high levels. Several transactions were recorded at 26c. per pound.

The Iron and Steel Market

PITTSBURGH, Oct. 20, 1922.

Fundamental conditions in the steel market have continued to soften. Buying of steel products has dropped to small proportions, the turnover in the past week having easily been the lightest in any week thus far this year. There have been no distinct declines in steel prices, but there is, generally speaking, an easier tone. This is seen definitely in the decreases that have occurred in the premiums that have to be paid to get early deliveries of sheets and plates. In bars the delivery premium is perhaps a shade less. In tin plates and wire products there have been no delivery premiums.

STEEL PRODUCTION

The prospect is that the mills with the leaner order books will soon have occasion to curtail production and that they will do this in preference to cutting prices in an effort to develop business. They will have some business, booked at prices recently prevailing, to protect. The Steel Corporation is well filled with business and will probably continue to run well. Two years ago a somewhat similar condition obtained. The corporation actually increased its operations slightly, fuel and labor becoming more plentiful, while the independents as a whole reached a low operating rate. In each case the corporation's better filled order book is to be ascribed to the following of a conservative policy in prices.

Car supplies at steel mills have not improved materially and little progress has been made in moving the steel recently piled. Shipping conditions have not grown worse, and there is less complaint among buyers.

STEEL PRICES

In general, steel products are steady at basis prices, 2c. being the basis for

bars, shapes and plates, while plain wire is 2.45c. and wire nails \$2.70. Prompt plates now rarely command more than 2.15c., while a fortnight ago 2.25c. was not uncommon and a month ago small lots were bringing as high as 2.50c. Prompt bars rarely bring 2.25c. now, but 2.15c. is not uncommon. In sheets the 3.35c. basis of the Steel Corporation is nominal in that the corporation is sold out until it opens its order books for first quarter. Among independents there have been prices of 3.50c., 3.60c. and 3.75c., according to the delivery the particular mill could make, but 3.75c. practically disappeared recently, and 3.60c. is now less common than 3.50c. as a settling price.

A curious incident is furnished by the National Tube Co. advancing its prices on welded tubular goods about \$4 a ton under date of Oct. 19. No change in prices had been expected, particularly when prices of other steel commodities are not in stiffening mood. Pipe advances, however, had been very conservative, and order books are better filled than is the case with some other steel products. The new basing discount is 66 per cent on merchant steel pipe. On last year's readjustment a minimum of 71 per cent was reached. The net advance from the low point, five points, figures out a trifle less than \$9 a net ton.

COKE

Connellsville furnace coke, which had ruled stiff at \$12 for several weeks, began softening about 10 days ago and then proceeded to break, offers of standard grade having been made yesterday and today at \$8 without finding takers. Production has continued to increase and when prices began to soften consumers became disposed to postpone purchases, so that from the demand and offerings standpoint the market has been under double pressure. With coal at \$3 the coke equivalent would be about \$5.75, so that there is room for more decline. Coke has sometimes sold at less than its coal equivalent.

PIG IRON

Pig iron, which was in very poor request throughout the period of exceptionally high prices when nearly all the merchant furnaces were idle, has been softening with the increasing production. The combination of consumers now receiving deliveries on old purchases and of prices declining naturally does not stimulate demand. Asking prices are down to \$33 for bessemer, \$30 for basic and \$32 for foundry, f.o.b. valley furnaces, and there may be little buying of real tonnages until prices have developed their new level, in keeping with coke at a reasonable price in relation to its cost of production. Wages at the union coal mines are the same as before the strike, while in the Connellsville region wages are up fully 40 per cent. In January and February coke sold at about \$3 and pig iron at \$18 to \$19, both coke and pig iron producers asserting these prices were below actual cost of production.

General Chemicals

Current Wholesale Prices in New York Market

	Carlots F.o.b. N. Y.	Less Carlots F.o.b. N. Y.	Carlots F.o.b. N. Y.	Less Carlots F.o.b. N. Y.
Acetic anhydride	lb.			
Acetone	lb.	\$0.22 - \$0.22		
Acid, acetic, 28 per cent.	100 lb.	2.80 - 2.90	2.95 - 3.50	
Acetic, 56 per cent.	100 lb.	5.60 - 5.75	5.80 - 6.25	
Acetic, glacial, 99 per cent, carboys	100 lb.	11.00 - 11.25	11.50 - 12.00	
Boric, crystals	lb.	11 - 11	11 - 12	
Boric, powder	lb.	11 - 11	11 - 12	
Citric	lb.		52 - 52	
Hydrochloric	100 lb.	1.10 - 1.20	1.25 - 1.70	
Hydrofluoric, 52 per cent	lb.	11 - 11	11 - 12	
Lactic, 44 per cent tech.	lb.	09 - 10	10 - 12	
Lactic, 22 per cent tech.	lb.	04 - 04	05 - 05	
Molybdic, e.p.	lb.	3.00 - 3.25	3.30 - 3.75	
Muriatic, 20 deg. (see hydrochloric)				
Nitric, 40 deg.	lb.	.06 - .06	.06 - .07	
Nitric, 42 deg.	lb.	.06 - .06	.07 - .07	
Oxalic, crystals	lb.	14 - 14	15 - 15	
Phosphoric, 50 per cent solution	lb.	.07 - .08	.08 - .09	
Pierie	lb.	20 - 22	23 - 27	
Pyrogallol, resublimed	lb.		1.65 - 1.75	
Sulphuric, 60 deg., tank cars	ton	9.50 - 10.00		
Sulphuric, 60 deg., drums	ton	12.00 - 14.00		
Sulphuric, 66 deg., tank cars	ton	15.00 - 16.00		
Sulphuric, 66 deg., drums	ton	19.00 - 20.00	20.50 - 21.00	
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.00 - 20.00		
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 - 22.50	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 - 32.00	33.00 - 34.00	
Tannic, U. S. P.	lb.		60 - 75	
Tannic (tech.)	lb.	40 - 45	46 - 50	
Tartaric, imported crystals	lb.		31 - 31	
Tartaric acid, imported, powdered	lb.		31 - 32	
Tartaric acid, domestic	lb.		32	
Tungstic, per lb. of WO ₃	lb.		1.00 - 1.10	
Alcohol, ethyl (Cologne spirit)	gal.		4.75 - 4.95	
Alcohol, methyl (see methanol)	gal.		36 - 38	
Alcohol, denatured, 188 proof No. 1	gal.		36 - 38	
Alcohol, denatured, 188 proof No. 5	gal.		36 - 38	
Alum, ammonia, lump	lb.	.03 - .03	.04 - .04	
Alum, potash, lump	lb.	.03 - .03	.04 - .04	
Alum, chrome lump	lb.	.05 - .05	.05 - .06	
Aluminum sulphate, commercial	100 lb.	1.50 - 1.65	1.70 - 2.12	
Aluminum sulphate, iron free	lb.	.02 - .02	.03 - .03	
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06 - .07	.07 - .08	
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .30	.30 - .31	
Ammonium carbonate, powder	lb.	.08 - .08	.09 - .09	
Ammonium nitrate	lb.	.06 - .06	.06 - .07	
Amylacetate tech.	gal.		2.35 - 2.50	
Arsenic, white, powdered	lb.	.10 - .10	.11 - .11	
Arsenic, red, powdered	lb.	.12 - .12	.13 - .13	
Barium carbonate	ton	75.00 - 77.00	78.00 - 80.00	
Barium chloride	ton	100.00 - 102.00	103.00 - 105.00	
Barium dioxide (peroxide)	lb.	.20 - .21	.21 - .22	
Barium nitrate	lb.	.09 - .09	.09 - .10	
Barium sulphate (precip.) (blanc fixe)	lb.	.04 - .04	.04 - .04	
Blanc fixe, dry	lb.	.04 - .04		
Blanc fixe, pulp	ton	45.00 - 55.00		
Bleaching powder	100 lb.	2.00 - 2.10	2.15 - 3.25	
Blue vitriol (see copper sulphate)	lb.	.05 - .05	.06 - .06	
Borax				
Brimstone (see sulphur, roll)				
Bromine	lb.	.27 - .38	.28 - .35	
Calcium acetate	100 lb.	3.00 - 3.15	3.20 - 3.50	
Calcium carbide	lb.	.04 - .04	.05 - .05	
Calcium chloride, fused, lump	ton	22.00 - 23.00	23.50 - 27.00	
Calcium chloride, granulated	lb.	.01 - .01	.02 - .02	
Calcium peroxide	lb.		1.40 - 1.50	
Calcium phosphate, tribasic	lb.		.15 - .16	
Camphor	lb.		.86 - .87	
Carbon bisulphide	lb.	.06 - .07	.07 - .07	
Carbon tetrachloride, drums	lb.	.10 - .10	.10 - .12	
Carbonyl chloride, (phosgene)	lb.		.60 - .75	
Caustic potash (see potassium hydroxide)				
Chalk, precip.—domestic, light	lb.	.04 - .04		
Chalk, precip.—domestic, heavy	lb.	.03 - .03		
Chalk, precip.—imported, light	lb.	.04 - .05		
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 - .05	.05 - .06	
Chloroform	lb.		.25 - .32	
Cobalt oxide	lb.		2.00 - 2.10	
Copper	ton	20.00 - 22.00	23.00 - 30.00	
Copper carbonate, green precipitate	lb.	.20 - .20	.20 - .21	
Copper cyanide	lb.		.58 - .600	
Copper sulphate, crystals	100 lb.	.75 - 6.00	6.10 - 6.504	
Cream of tartar	lb.		.26 - .27	
Epsom salt (see magnesium sulphate)	lb.			
Ethyl acetate com. 85%	gal.		.60 - .65	
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.		.90 - .95	
Formaldehyde, 40 per cent	lb.	.13 - .13	.14 - .14	
Fullers earth, f.o.b. mines	net ton	16.00 - 17.00		
Fullers earth—imported powdered	net ton	30.00 - 32.00		
Fuse oil, ref.	gal.		2.75 - 2.90	
Fuse oil, crude	gal.		1.65 - 1.85	
Glauber's salt (see sodium sulphate)	lb.		.18 - .18	
Glycerine, e.p. drums extra	lb.		4.40 - 4.50	
Iodine, resublimed	lb.		.12 - .18	
Iron oxide, red	lb.		.11 - .12	
Lead acetate, white crystals	lb.		.13 - .14	
Lead arsenate, powd.	lb.		.15 - .20	
Lead nitrate	lb.		.07 - .08	
Litharge	lb.		.08 - .09	
Magnesium carbonate, technical	100 lb.	.06 - .06	.061 - .071	
Magnesium sulphate, U.S.P.	100 lb.	2.00 - 2.25	2.30 - 2.50	
Magnesium sulphate, technical	100 lb.		1.00 - 1.80	
Methanol, 95%	gal.		.90 - .92	
Methanol, 97%	gal.		.92 - .94	
Nickel salt, double	lb.		.11 - .11	
Nickel salt, single				lb.
Phogene (see carbonyl chloride)				lb.
Phosphorus, red				lb.
Phosphorus, yellow				lb.
Potassium bichromate				lb.
Potassium carbonate, U. S. P.				lb.
Potassium carbonate, 80-85%				lb.
Potassium chloride powdered and crystals				lb.
Potassium cyanide				lb.
Potassium hydroxide (caustic potash), 100 lb.				lb.
Potassium iodide				lb.
Potassium nitrate				lb.
Potassium permanganate				lb.
Potassium prussiate, red				lb.
Potassium prussiate, yellow				lb.
Rochelle salts (see sodium potas tartrate)				lb.
Sal ammoniac, white, granular				lb.
Sal ammoniac, gray, granular				lb.
Salsoda				100 lb.
Salt cake (bulk)				ton
Soda ash, light, 58 per cent flat, bags, contract				100 lb.
Soda ash, light, 58 per cent flat, bags, resale				100 lb.
Soda ash, dense, in bags, resale				100 lb.
Sodium acetate				lb.
Sodium bicarbonate				100 lb.
Sodium bichromate				lb.
Sodium bisulphite (nitre cake)				ton
Sodium bisulphite powdered, U.S.P.				lb.
Sodium chlorate				long ton
Sodium cyanide				lb.
Sodium fluoride				lb.
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract				100 lb.
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale				100 lb.
Sodium hydroxide (caustic soda), ground and flake, contracts				100 lb.
Sodium hydroxide (caustic soda) ground and flake, resale				100 lb.
Sodium hypophosphate				lb.
Sodium nitrite				lb.
Sodium peroxide, powdered				lb.
Sodium phosphate, dibasic				lb.
Sodium potassium tartrate (Rochelle salts)				lb.
Sodium prussiate, yellow				lb.
Sodium silicate, (40 deg. in drums)				100 lb.
Sodium silicate, (60 deg. in drums)				100 lb.
Sodium sulphate, crystallized (Glauber's salt)				100 lb.
Sodium sulphide, f.i. sed, 60-62 per cent (cone.)				lb.
Sodium sulphite, crystals				lb.
Strontium nitrate, powdered				lb.
Sulphur chloride, yellow				ton
Sulphur, crude				18.00 - 20.00
Sulphur dioxide, liquid, cylinders extra				lb.
Sulphur (sublimed), flour				100 lb.
Sulphur, roll (brimstone)				100 lb.
Tale—imported				ton
Tale—domestic powdered				ton
Tin bichloride				lb.
Tin oxide				b.
Zinc carbonate				b.
Zinc chloride, gran.				lb.
Zinc cyanide				lb.
Zinc oxide, XX				lb.
Zinc sulphate				100 lb.

Coal-Tar Products

Alpha-naphthal, crude.	lb.	\$0.95 - \$1.00
Alpha-naphthal, refined	lb.	1.10 - 1.15
Alpha-naphthylamine	lb.	.29 - .31
Aniline oil, drum, extra	lb.	.16 - .17
Aniline salts	lb.	.22 - .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 - 1.00
Benzaldehyde, U.S.P.	lb.	1.25 - 1.35
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 - .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 - .32
Benzidine, base	lb.	.85 - .95
Benzidine sulphate	lb.	.80 - .85
Benoic acid, U.S.P.	lb.	.72 - .75
Benzoyl acid, U.S.P.	lb.	.57 - .65
Benzyl chloride, 95-97%, refined	lb.	.25 - .27
Benzyl chloride, tech.	lb.	.20 - .23
Beta-naphthol benzene	lb.	.375 - .400
Beta-naphthol, sublimed	lb.	.53 - .55
Beta-naphthol, tech.	lb.	.23 - .25
Beta-naphthylamine, sublimed	lb.	.150 - 1.60
Carbazole	lb.	.75 - .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.14 - .20
Ortho-eresol, in drums (100 lb.)	lb.	.18 - .22
Cresylic acid, 97-99%, straw color, in drums	gal.	.60 - .65
Cresylic acid, 55-57%, dark, in drums	gal.	.55 - .58
Dichlorobenzene	lb.	.06 - .09
Diethylamine	lb.	.32 - .34
Dimethylamine	lb.	.20 - .22
Dinitrobenzene	lb.	.21 - .22
Dinitrochlorobenzene	lb.	.30 - .32
Dinitronaphthalene	lb.	.32 - .34
Dinitrophenol	lb.	.22 - .24
Dinitrotoluene	lb.	.22 - .24
Dip oil, 25%, car lots, in drums	gal.	.85 - .90
Diphenylamine	lb.	.54 - .56
Di- <i>u</i> -acid	lb.	.72 - .75
Meta-phenylenediamine	lb.	.90 - 1.00
Monochlorobenzene	lb.	.10 - .11
Monooethylbenzene	lb.	.95 - 1.10
Naphthalene crushed, in bbls.	lb.	.06 - .08
Naphthalene, flake	lb.	.06 - .07
Naphthalene, balls	lb.	.07 - .08
Naphthionate of soda	lb.	.58 - .65
Naphthionic acid, crude	lb.	.65 - .70
Nitrobenzene	lb.	.10 - .12
Nitro-naphthalene	lb.	.30 - .35

Nitro-toluene.....	lb.	\$0.15	—	\$0.10
N-W. acid.....	lb.	1.20	—	1.30
Ortho-aminophenol.....	lb.	2.10	—	2.15
Ortho-dichlor-benzene.....	lb.	.17	—	.20
Ortho-nitro-phenol.....	lb.	.80	—	.85
Ortho-nitro-toluene.....	lb.	.12	—	.15
Ortho-toluidine.....	lb.	.12	—	.14
Para-aminophenol, base.....	lb.	1.20	—	1.25
Para-aminophenol, HCl.....	lb.	1.25	—	1.30
Para-dichlorbenzene.....	lb.	.17	—	.20
Paranitroaniline.....	lb.	.72	—	.80
Para-nitrotoluene.....	lb.	.55	—	.65
Para-phenylenediamine.....	lb.	1.55	—	1.60
Para-toluidine.....	lb.	.85	—	.90
Phthalic anhydride.....	lb.	.35	—	.38
Phenol, U. S. P., drums.....	lb.	.26	—	.27
Pyridine.....	gal.	1.60	—	1.75
Resorcinol, technical.....	lb.	1.50	—	1.55
Resorcinol, pure.....	lb.	2.00	—	2.10
R-salt.....	lb.	.55	—	.60
Salicylic acid, tech., in bbls.....	lb.	.29	—	.30
Salicylic acid, U. S. P.....	lb.	.32	—	.34
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.27	—	.32
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.12	—	.14
Sulphanilic acid, crude.....	lb.	.24	—	.26
Toluidine.....	lb.	1.20	—	1.30
Toluidine, mixed.....	lb.	.30	—	.35
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.30	—	.35
Xyliodines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, commercial, in drums, 100 gal.....	gal.	.45	—	—
Xylene, commercial, in tank cars.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	—

Waxes

Prices remain quatably unchanged.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$6.70	—	—
Rosin E-I.....	280 lb.	6.70	—	—
Rosin K-N.....	280 lb.	6.75	—	\$6.85
Rosin W. G.-W. W.....	280 lb.	7.75	—	8.25
Wood rosin, bbl.....	280 lb.	6.25	—	—
Spirits of turpentine.....	gal.	1.65	—	1.70
Wood turpentine, steam dist.....	gal.	1.15	—	—
Wood turpentine, dest. dist.....	gal.	1.12	—	.70
Pine tar pitch, bbl.....	200 lb.	—	—	6.00
Tar, kiln burned, bbl (500 lb.).....	bbl.	—	—	9.50
Resotar tar, bbl.....	500 lb.	—	—	9.00
Rosin oil, first run.....	gal.	.38	—	—
Rosin oil, second run.....	gal.	.41	—	—
Rosin oil, third run.....	gal.	.48	—	—
Pine oil, steam dist., sp.gr., 0.930-0.940.....	gal.	1.00	—	—
Pine oil, pure, dest. dist.....	gal.	.95	—	—
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46	—	—
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35	—	—
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—	—
Pine tar, ref., thin, sp.gr., 1.080-1.160.....	gal.	.25	—	—
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.25	—	—
Pinewood creosote, ref.....	gal.	.52	—	—

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags.....	100 lb.	3.65	—	3.75
Blood, dried, f.o.b., N. Y.....	unit	4.60	—	—
Bone, 3 and 50, ground, raw.....	ton	42.00	—	44.00
Fish scrap, dom., dried, f.o.b. works.....	unit	3.10	—	3.20
Nitrate of soda.....	100 lb.	2.35	—	2.45
Tankage, high grade, f.o.b. Chicago.....	unit	4.50	—	4.60
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%.....	ton	3.50	—	4.00
Tennessee, 78-80%.....	ton	7.00	—	8.00
Potassium muritate, 80%.....	ton	33.00	—	34.00
Potassium sulphate.....	unit	1.00	—	—

Crude Rubber

Quotations remain same as previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.	lb.	\$0.12	—	\$0.13
Castor oil, No. 3, in bbls.....	lb.	.13	—	.13
Castor oil, AA, in bbls.....	lb.	.12	—	.12
China wood oil, in bbls.....	lb.	.08	—	.08
Coconut oil, Ceylon grade, in bbls.....	lb.	.08	—	.09
Coconut oil, Cochin grade, in bbls.....	lb.	.08	—	.09
Corn oil, crude, in bbls.....	lb.	.08	—	.09
Cottonseed oil, crude (f. o. b. mill).....	lb.	.07	—	—
Cottonseed oil, summer yellow.....	lb.	.10	—	.10
Cottonseed oil, winter yellow.....	lb.	.11	—	.11
Linseed oil, raw, ear lots (domestic).....	gal.	.87	—	.88
Linseed oil, raw, tank cars (domestic).....	gal.	.84	—	.85
Linseed oil, boiled, in 5-bbl lots (domestic).....	gal.	.90	—	.91
Olive oil, denatured.....	gal.	1.15	—	1.17
Palm, Lagos.....	lb.	.07	—	.07
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.12	—	.12
Rapeseed oil, refined in bbls.....	gal.	.77	—	.78
Rapeseed oil, blown, in bbls.....	gal.	.85	—	.86
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.11	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.08	—	.09

FISH

Light pressed menhaden.....	gal.	10.51	—	—
White bleached menhaden.....	gal.	.54	—	.55
Blown menhaden.....	gal.	.61	—	—
Whale Oil, No. 1, crude, tanks, coast.....	gal.	.45	—	.48

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b., Quebec, Canada...short ton	ton	\$600.00	—	\$800.00
Asbestos, shingle stock, f.o.b., Quebec, Canada...short ton	ton	65.00	—	80.00
Asbestos, cement stock, f.o.b., Quebec, Canada...short ton	ton	15.00	—	17.00
Barytes, ground, white, f.o.b. mills.....	net ton	17.00	—	23.00
Barytes, ground, off color f.o.b. mills.....	net ton	13.00	—	21.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude f.o.b. mines.....	net ton	8.00	—	9.00
Casein.....	lb.	.10	—	.13
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.00	—	8.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	8.00	—	9.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	12.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin) imported, lump.....	net ton	16.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, No. 1 pottery grade.....	long ton	7.00	—	7.50
Feldspar, No. 2 pottery grade.....	long ton	5.75	—	5.90
Feldspar, No. 1 soap grade.....	long ton	7.00	—	7.50
Feldspar, No. 1 Canadian, for mill.....	long ton	21.00	—	22.00
Graphite, Ceylon lump, first quality, f.o.b. N. Y.....	lb.	.05	—	.05
Graphite, Ceylon chip.....	lb.	.04	—	.04
Graphite, high grade amorphous crude.....	ton	35.00	—	50.00
Kieselguhr, f.o.b. mines, Cal. *	per ton	40.00	—	—
Kieselguhr, f.o.b. N. Y. *	per ton	50.00	—	55.00
Magnesite, crude, f.o.b. California mines.....	per ton	12.00	—	15.00
Pumice stone, imported.....	lb.	.03	—	.05
Pumice stone, domestic, lump.....	lb.	.05	—	.05
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Shellac, orange fine.....	lb.	.59	—	.60
Shellac, orange superfine.....	lb.	.61	—	.62
Shellac, A. C. garnet.....	lb.	.63	—	.64
Shellac, T. N. *	lb.	.57	—	.58
Silica, glass sand, f.o.b. Indiana.....	per ton	1.50	—	2.50
Silica, sand blast material, f.o.b. Indiana.....	per ton	2.50	—	3.00
Silica, amorphous, 250 mesh, f.o.b. Illinois.....	per ton	16.00	—	16.00
Silica, building sand, f.o.b. Pa. *	per ton	2.00	—	2.75
Soapstone.....	ton	12.00	—	15.00
Talc, 200 mesh, f.o.b. Vermont.....	ton	7.00	—	12.00
Talc, 200 mesh, f.o.b. Georgia.....	ton	7.50	—	12.00
Talc, 200 mesh, f.o.b. Los Angeles.....	ton	15.00	—	17.00

Refractories

Prices remain quatably unchanged.

Ferro-Alloys

Prices remain same as previous report.

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. ship- ping points.....	net ton	\$6.00	—	\$9.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic sea- board.....	ton	19.00	—	20.00
Coke, foundry, f.o.b. ovens.....	net ton	12.00	—	12.50
Coke, furnace, f.o.b. ovens.....	net ton	9.00	—	9.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	—
Fluorspar, standard, domestic, washed gravel Kentucky and Illinois mines.....	net ton	17.50	—	19.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.45	—	—
Manganese ore, chemical (MnO ₂).....	net ton	70.00	—	75.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y. *	lb.	.80	—	.85
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	27.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic sea- port.....	unit	.10	—	.11
Pyrites, Spanish, furnace size, c.i.f. Atlantic sea- port.....	unit	.12	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	Nominal	—	—
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.12	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	8.00	—	8.25
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	7.75	—	8.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	—
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04	—	.13

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

Copper, electrolytic.....	Cent per Lb.	14.00

</tbl_r

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

TARRANT CITY—The National Cast Iron Pipe Co. has preliminary plans in progress for the erection of a new foundry. A special system for cast-iron pipe production will be installed. It is expected to commence work early in the coming year.

MOBILE—The Patterson Oil Co., Conception and Virginia Aves., is reported to be planning for the immediate rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$60,000, including equipment.

TUSCALOOSA—Fire, Oct. 3, destroyed Foundry No. 3, at the local plant of the Central Foundry Co., with loss estimated at about \$65,000. It is planned to rebuild at a later date. Headquarters of the company are at 41 East 42nd St., New York.

Arkansas

PINE BLUFF—The Jefferson County Cotton Oil Co. is installing new equipment at its plant for considerable increase in capacity. I. L. Hathaway is general manager.

FORT SMITH—The Athletic Mining & Smelting Co. has plans under way for enlargements in its plant, to include the installation of about 1,600 new retorts, arranged in two major blocks, and a new kiln at the zinc smelter. It is expected to commence work early in 1923.

FORT SMITH—The Zenor Bottle Co. has plans under consideration for the installation of new equipment at its plant. The company was recently incorporated with a capital of \$50,000, to take over a local plant. C. P. Zenor is president, and James B. McDonough, vice-president.

CAMDEN—The Bradstreet Oil Co. is planning for enlargements in its storage and distributing plant. A number of new 55,000-bbl. storage tanks, with auxiliary equipment, will be installed.

Colorado

DENVER—The Producers' & Refiners' Corp., California Bldg., has plans in progress for the construction of a new oil-refining plant in the vicinity of Fort Steele, Wyo. It is also proposed to build a similar plant at Omaha, Neb. New pipe lines, pumping plants, etc., will be installed.

Florida

JACKSONVILLE—The Tidewater Glass Mfg. Co. has awarded a general contract to Frank Richardson, Jacksonville, for the erection of a new plant on local site to cost about \$150,000, including machinery. Work will be placed under way at once.

California

LOS ANGELES—The Amalgamated Talc Co. has plans nearing completion for the construction of a new 1-story plant, 40x160 ft., on East 1st St. Milling machinery, cleaning apparatus and other equipment will be installed. A. Godfrey Bailey, Junior Orpheum Bldg., is architect.

OLEUM—Fire, Oct. 1, destroyed a portion of the oil storage and distributing plant of the Union Oil Co., Los Angeles, in the San Pablo Bay district, with loss estimated at about \$250,000, including tanks, stock, etc. It is planned to rebuild.

LOS ANGELES—The W. P. Fuller Paint Co., Los Angeles, is taking bids through Hudson & Munsell, 444 Douglas Bldg., architects, for the erection of a new 1-story plant at Barranca St. and Ave. 22, estimated to cost approximately \$40,000.

LOS ANGELES—The Shell Oil Co. of California, San Francisco, is planning for enlargements in its plant in the harbor section, to include a new refinery in the vicinity of Wilmington, for handling the output of the Signal Hill oil wells. The work is estimated to cost close to \$1,000,000, including machinery.

LOS ANGELES—The Kay-Brunner Co. has awarded a contract to the Austin Co., Pacific Electric Bldg., for the erection of a 1-story foundry, 56x152 ft., on Frederick St., near Cypress Ave.

Georgia

AUGUSTA—The plant and property of the Planters' Cotton Oil Co. have been acquired by new interests, headed by John Aspewgren. The new owners will operate the mill and have tentative plans under consideration for extensions and improvements.

Illinois

OLMSTEAD—The Sinclair Refining Co., 111 West Washington St., Chicago, has completed plans and will commence work early in December, for a new 1-story mill, 70x115 ft., here, for the production of fullers earth.

Indiana

EVANSVILLE—The Evansville Enameling Co. has plans in progress for the erection of a new 1-story plant addition, 50x85 ft., sawtooth roof type.

Kentucky

RUSSELLVILLE—The Independence Nitro Co. has plans under way for the erection of a new local plant for the production of nitroglycerine and kindred products.

Louisiana

GRETNA—The Gulf Refining Co., New Orleans, has plans in progress for the installation of a new storage and distributing plant on local site.

Maryland

CUMBERLAND—The Better Brick Co., recently organized, has acquired a tract of property on the Allegheny Grove district, and plans for the construction of a new plant for the manufacture of hollow tile blocks, concrete brick and kindred products. The works will consist of a number of buildings. Theodore Smith is general manager.

BALTIMORE—The Argol Sulphide Co. has acquired a tract of land, totaling about 2 acres, on Curtis Ave., Curtis Bay, for a consideration of about \$10,000, and is said to be planning to use the site for a new plant. It has been held heretofore by the Standard Wholesale Phosphate Co.

BALTIMORE—The American Oil Co., American Bldg., has purchased a portion of the Smith's shipyard property at Curtis Bay, consisting of about 10 acres, and has tentative plans under consideration for a new storage, handling and distributing plant, estimated to cost close to \$500,000, including machinery.

BALTIMORE—The Crown Oil & Wax Co., 22 South Eighth St. is planning for the rebuilding of the portion of its plant destroyed by fire, Oct. 10. An official estimate of loss has not been announced.

BALTIMORE—The Bartlett-Hayward Co., Scott and McHenry Sts., will build a new 1-story foundry, 200x262 ft., at its iron and steel works. The erection contract has been let to the Whiting Turner Construction Co., 427 East Lombard St. Howard Bruce is president.

Massachusetts

CLINTON—The Clinton Gas Light Co., Pleasant St., has plans in progress for the construction of a new artificial gas plant. Walter W. Russell, 77 Franklin St., Boston, is engineer.

Michigan

DETROIT—The Detroit Foundry Co., Grand Boulevard and Orleans St., has leased the former foundry of the American Blower Co., in the vicinity of its plant, with building totaling about 50,000 sq.ft. of floor space, on 2-acre site, and will use the property for immediate extensions. The privilege of purchase at a later date has also been secured.

Missouri

CAPE GIRARDEAU—The McCracken Pipe Co., Sioux City, Ia., has tentative plans under consideration for the erection of a new plant on local site, for the manufacture of concrete sewer pipe and other concrete pipe products. It is estimated to cost about \$30,000. J. W. McCracken is president.

MALDEN—The Roberts Cotton Oil Co. is considering the rebuilding of the portion of its plant, recently destroyed by fire, with loss estimated at about \$25,000.

Montana

NEIHART—The American Zinc & Lead Co. has awarded a contract to the Stearn-Rogers Mfg. Co., Denver, Colo., for the construction of a new concentrating mill, estimated to cost in excess of \$500,000. Work will be placed under way at an early date.

Nebraska

OMAHA—The Standard Chemical Co. has taken possession of its new plant at 42nd St. and Leavenworth Ave. and removed its former works on Harvey St. to this location. Considerable increased capacity will be provided.

New Jersey

GLoucester—The City Council will soon award a contract for the installation of a new filtration plant at the municipal water-works.

NEWARK—The W. H. Hughes Co., Inc., 507 West 35th St., New York, manufacturer of enamels, paints, lacquers, etc., has leased the entire building at 164 Coit St., Irvington, heretofore held by the Pierce, Butler, Pierce Mfg. Co., New York, manufacturer of boilers, etc. The new owners will take immediate possession for a branch plant.

New York

NEW YORK—The American Smelting & Refining Co., 120 Broadway, has plans in progress for extensions and improvements in its plants in Colorado to cost in excess of \$5,000,000, including buildings and machinery.

Ohio

PORT CLINTON—The American Gypsum Co. has plans in preparation for the erection of a 1- and 2-story addition to its local plant, 65x70 ft., to be used for the manufacture of wall plaster and kindred products.

CLEVELAND—The Otis Steel Co., Jennings Ave., is having revised plans prepared for the erection of its proposed new plant addition, estimated to cost close to \$3,000,000. It is proposed to construct the mills with force employed directly by the company.

DAYTON—The Lowe Brothers Co., 452 East 3rd St., has construction under way on a new addition to its paint manufacturing plant. John M. Lowe is president.

Oklahoma

HOLDENVILLE—The C. R. Cordell Oil Co. has plans under way for the construction of a new compounding and blending plant for the production of lubricating oils.

CUSHING—The Shaffer Refining Co. will soon commence the erection of an addition to its local plant, comprising a new four-unit cracking mill, estimated to cost approximately \$500,000. It is proposed to have the new plant ready for service in the spring of the coming year.

OKLAHOMA CITY—The Mineral Bank Mining Co., 507 Baltimore Bldg., has inquiries out for a new ball mill, to be used in connection with its gold concentrating and amalgamating plant.

Pennsylvania

PHILADELPHIA—The Independence Mfg. Co., Araminto St. and Wheatsheaf Lane, manufacturer of greases, tallow, etc., has filed plans for the erection of a new 1-story building at Coral St. and Wheatsheaf Lane.

PHILADELPHIA—The Philadelphia Cut Glass Co., Redfield St., near Baltimore Ave., has awarded a contract to the Farrell Roth Construction Co., 122 Diamond St., for the erection of a new 1-story plant, 80x90 ft.

PUNXUTAWNEY—The Elk Run Window Glass Co. is planning for the rebuilding of the portion of its plant destroyed by fire, Oct. 3, with loss of about \$12,000.

PHILADELPHIA—The Precision Grinding Wheel Co., 8301 Torresdale Ave., manufacturer of abrasive materials, will commence the immediate erection of a new 1-story plant addition.

PHILADELPHIA—Fire, Oct. 5, destroyed a large portion of the plant of H. Swoboda & Son, Inc., Bodine St., manufacturer of leather products, with loss estimated in excess of \$150,000, including equipment.

LOCK HAVEN—The American Aniline Products Co. has plans under way for the construction of a new 3-story factory, 45x90 ft., to replace a fire loss of a number of months ago. It will be equipped for grinding and other service. Another structure of approximately like size will also be built.

Tennessee

ROCKWOOD—The Roane Iron Co. has tentative plans under consideration for the rebuilding of the portion of its local plant, recently destroyed by fire with loss estimated in excess of \$100,000, including equipment.

Texas

HOUSTON—The Houston Terminal Refining Co., recently organized with a capital of \$500,000, has plans in progress for the enlargement of its local oil refinery, comprising the former plant of Hoffman & Turnblow, lately acquired. The purchase includes 28 acres of land on the Houston Ship Canal, a portion of which will be used for the proposed expansion.

DALLAS—The Southwestern Dehydration Co., 409 Andrews Bldg., recently organized with a capital of \$125,000, has acquired a local 4-story building, 75x125 ft., and will commence the immediate installation of equipment for a new plant.

CORISICANA—Fire, Oct. 3, destroyed a portion of the plant of the Southland Cotton Oil Co., with loss estimated at about \$80,000. Plans for rebuilding are under consideration. C. C. Roberts is local manager.

BRAZORIA—The Union Sulphur Co., Sulphur, La., has acquired a tract totaling about 210 acres of land at Brazoria, as a site for the erection of a new mining, refining and terminal plant, estimated to cost in excess of \$4,000,000, including machinery.

Virginia

BIG STONE GAP—The W. W. Taylor & Son Co. is planning for the establishment of a local plant for the manufacture of bricks and kindred burned clay products. Inquiries are being made for various equipments for installation.

Washington

EVERETT—The Whitman County Iron Co. has negotiations under way with the local Chamber of Commerce for a new site for the erection of a steel mill, with blast furnace and other structures. The initial capacity of the plant will be about 50 tons daily. E. G. Hammer is vice-president in charge.

VANCOUVER—The local Chamber of Commerce has negotiations under way with a company, whose name will be announced at a later date, for a suitable site for the erection of a new mill for molybdenum steel production. John O. Bender, Los Angeles, Calif., is interested in the project.

West Virginia

PARKERSBURG—The General Porcelain Co. has commenced the erection of its proposed plant—1-story plant addition, 65x225 ft., estimated to cost about \$25,000.

Industrial Developments

RUBBER—The Republic Rubber Co. has resumed operations in the tire-making department at its Youngstown, O., plant, following a shut-down for close to 2 years past. The inner tube and mechanical rubber goods departments at this factory are running full, with normal working force. The tire-manufacturing department at the Canton O., plant of the company is operating under a capacity schedule.

The Mason Tire & Rubber Co., Akron, O., has adopted a capacity operating schedule and expects to remain on this basis throughout the winter.

The Goodrich Tire & Rubber Co., Akron, O., is running on a production basis of about 20,000 tires a day, with full-time working force.

METALS—The Federal Steel Foundry Co., Chester, Pa., has resumed operations at its steel foundries, following an extended curtailment.

The Calumet & Hecla Co., Calumet, Mich., is running full at its local smelting plant, and has recently advanced the wage scale

about 11 per cent, affecting practically all classes of labor at the mills.

The Jennings Brothers' Co., Bridgeport, Conn., producer of gold and bronze products, is increasing production at its plant, and a number of additions are being made in the working force. Business is about 50 per cent better than at this same time a year ago.

The United States Cast Iron Pipe & Foundry Co., Burlington, N. J., is operating at full capacity at its local plant, with employment of regular working force.

The Utah Consolidated Mining Co., Tooele, Utah, is operating at capacity at its new milling plant, and is also running full at its copper smelter. A large working force is being employed.

The American Brass Co., Waterbury, Conn., is advancing production to a point in excess of pre-war production at its different plants. All of the mills in the Naugatuck Valley are running close to capacity, while western plants will soon be on a similar basis. Additional workers have been added.

The Davis-Daly Co., Butte, Mont., is running on one full-time shift at its local properties, with present output totaling about 500 tons of copper ore per day.

The Park-Utah Mining Co., Salt Lake City, Utah, is advancing production at its copper properties from 160 to 250 tons. An increased working force is being employed.

The Ray Consolidated Copper Co., Ray, Ariz., is increasing production at its mills. The wage scale has been advanced recently 10 per cent.

The American Smelting & Refining Co., New York, is advancing operations at its Mexico mills, and will make substantial additions in the working force.

IRON AND STEEL—The Delaware River Steel Co., Chester, Pa., is arranging for the early resumption of operations at its plant after a shut-down since December, 1920. The plant normally gives employment to about 350 men, and initial production will be increased gradually to this full working quota.

There are now 27 blast furnaces in operation in the Mahoning Valley district, Ohio, which equals the highest record of production for the year, established several months ago before the recent curtailment.

The Foley Steel Mills, Slatington, Pa., have resumed operations after a curtailment of a number of months.

The Carnegie Steel Co. has blown in blast furnace No. 1 at its Sharon, Pa., works, following a shut-down for about 8 weeks. Two out of three stacks are now in operation at this plant.

The Illinois Steel Co., Chicago, Ill., has 15 blast furnaces in service at its plant and has advanced steel production to about 70 per cent of mill capacity.

The Bethlehem Steel Co. has blown in another blast furnace at its Steelton, Pa., plant, making three units now in service here.

The Brier Hill Steel Co., Youngstown, O., has established a new high record for steel ingot production at its local 12-in. furnace, with output for September totaling 68,197 ingot tons, compared with previous high figures in October, 1920, of 67,640 tons. The new production total is said to be a world's record.

The American Steel & Wire Co. has resumed operations at its hot mills at Sharon, Pa.

The Altoona Iron Co., Altoona, Pa., has resumed production at its local plant with a 60 per cent operating force. This will be increased gradually to normal. The plant is said to have sufficient orders on hand to insure continuous operations for a number of months.

The Inland Steel Co., Chicago, Ill., has all three blast furnaces in service at its plant and has placed the steel mills on a basis of about 65 per cent of capacity.

The American Sheet & Tin Plate Co. has started up all remaining hot mills at its Farrell, Pa., works, totaling 30, bringing production in this department to capacity for the first time in more than 2 years. Extensive additions will be made in the working force.

CERAMIC—The Jackson Vitrified China Co., Falls Creek, Pa., has granted the demand of employees for a 7 per cent wage advance, affecting about 100 workers. The men have returned to work after a brief strike.

A total of seven general ware plants at Trenton, N. J., are now inactive, owing to the strike of pottery operatives for increased wages. These are the two plants of the Greenwood Pottery Co., International

Pottery Co., Cook Pottery Co., Mercer Pottery, the Lamberton Works of the Maddock Pottery Co., and the Unger Pottery. It is estimated that 2,000 workers are idle.

The Mt. Clemens Pottery Co., Mt. Clemens, Mich., has granted the demand of employees for a 7 per cent wage increase, and operations have been resumed at the pottery.

The Southern Potteries Co., Erwin, Tenn., has met the demand of employees for a 7 per cent wage advance, and production has been resumed at full capacity.

MISCELLANEOUS—The Hollow Ware & Enameling Co., Lancaster, Pa., is running full at its local plant, giving employment to more than 200 workers. A wage advance of 5 per cent for molders and laborers has recently been placed into effect.

The Montana Refining Co., Billings, Mont., has completed enlargements at its local oil refinery, providing a capacity close to double the previous output. The entire mill will be placed in service at an early date.

The Southwestern Graphite Co. has resumed operations at its works at Burnett, Tex., following a considerable curtailment.

Following a shut-down since Aug. 9 for necessary curtailment and repairs, the Interstate Glass Co. has resumed operations at its plant at Kane, Pa., giving employment to about 300 men.

The International Products Co., New York, manufacturer of tanning materials, is operating its quebracho plant in Paraguay at full capacity, on a basis of 25,000 tons per annum. This is an increase from 17,000 tons, produced in 1921, and 8,527 tons in 1920.

New Companies

THE UNION CHEMICAL CO., Burlington, N. J., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are Joseph Harrison, Harry M. Barg and Warren R. Rahn, all of Burlington. The last noted represents the company.

THE (N-G-R) ENERGY CO., 730 North Franklin St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture washing compounds and kindred specialties. The incorporators are A. E. and R. E. Anderson, and Frank T. Tolukuehn.

THE GILL LEATHER CO., Salem, Mass., has been incorporated with a capital of \$50,000, to manufacture leather products. John Gill, Wisteria St., Salem, Mass., is president and treasurer, and represents the company.

THE S. JACK HAINES CORP., New York, N. Y., care of J. J. Ryan, 355 East 149th St., representative, has been incorporated with a capital of \$10,000, to manufacture shellacs, varnishes, etc. The incorporators are S. Jack Haines and M. Spitzer.

THE BOWIE COTTON OIL CO., Bowie, Tex., has been incorporated with a capital of \$150,000, to manufacture cotton oil products. The incorporators are H. O. Bannon and R. C. Feagin, both of Bowie.

THE CLINCHFIELD MICA CORP., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$1,000,000, to manufacture mica products.

THE NOVATONE CO., Brooklyn, N. Y., care of J. H. Garmes, 51 Chambers St., New York, N. Y., representative, has been incorporated with a capital of \$5,000, to manufacture paints, dyes and allied products. The incorporators are L. and M. Ornstein, and J. Randolph.

THE MID-CITY FOUNDRY CORP., 1901 Rockwell St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture iron, steel and other metal castings. The incorporators are Frank Cedarwell, Innard Dahlberg and Carl J. Berg.

THE ARRENDALE OIL CO., El Dorado, Ark., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are Samuel Arrendale, and W. L. Breyfogle, both of El Dorado; and W. M. Hall, Kansas City, Mo.

THE HIGH-GRADE LEMON POLISHING CO., 144 Parker St., Newark, N. J., has filed notice of organization to manufacture polishing oils. The company is headed by Michael Monetti.

THE TARRANTINE MFG. CO., INC., Bangor, Me., has been incorporated with a capital of \$96,000, to manufacture soap products. Hugo H. Hanson is president; Samuel F. Chalfin, treasurer; and Charles D. Bart-

lett, clerk, all of Bangor. The last noted represents the company.

THE RISHER FIRE BRICK CO., Room 842, 10 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$40,000, to manufacture firebrick, tile and other refractory products. The incorporators are Howard E. and E. B. Risher, and Herbert O. Engstrom.

THE PORTABLE REFINERY CO., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$500,000, to manufacture petroleum products.

THE ALBION MECHANICAL RUBBER MFG. CO., Richmond, S. I., N. Y., care of B. O. Eadie, St. George, S. I., representative, has been incorporated with a capital of \$5,000, to manufacture mechanical rubber products. The incorporators are J. E. E. M. and K. V. Dubois.

THE BIRMINGHAM, LITTLE & PROSSER CO., Kansas City, Mo., has been incorporated with a capital of \$60,000, to manufacture paper products. The incorporators are John Birmingham, E. H. Becker and Con J. Murphy, all of Kansas City.

THE SLENDAFORM CORP., New York, N. Y., care of Harry S. Hechheimer, 1540 Broadway, representative, has been incorporated with a capital of \$20,000, to manufacture chemicals and affiliated products. The incorporators are W. N. Hechheimer and G. J. Lloyd.

THE LLOYD-BRECKENRIDGE GREASE CO., 608 South Dearborn St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture lubricating oils, greases, etc. The incorporators are W. H. Breckenridge, C. B. Lloyd, and R. S. Robbins.

THE TWO STATES LIME CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$1,500,000, to manufacture lime products.

THE REED-MACLAURY RUBBER CO., St. Louis, Mo., has been incorporated with a capital of \$10,000, to manufacture rubber specialties. The incorporators are A. A. and B. E. Reed, and J. D. Maclaury, all of St. Louis.

THE NEWTON OIL CO., Newton, Mass., has been incorporated with a capital of \$200,000, to manufacture oil products. Daniel J. Sullivan, 37 Glenwood Ave., Newton Centre, Mass., is president and treasurer.

THE KO-KONDEL CO., Houston, Tex., has been incorporated with a capital of \$14,000, to manufacture chemical specialties, insecticides, etc. The incorporators are T. E. J. W. and H. F. Harrington, all of Houston.

THE ALBANY STEEL & BRASS CORP., 716 West Madison St., Chicago, Ill., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture steel, brass, bronze and other metal products. The incorporators are J. Kendall, Herbert Green and G. Mitchell.

THE UNITED STATES & MEXICAN OIL CO., Richmond, Va., has been incorporated with a capital of \$15,000,000, to manufacture petroleum products. The incorporators are Cyrus W. Beale and Guy B. Hazlegrove, both of Richmond, who will act as president and secretary, respectively.

THE NIAGARA CHEMICAL CO., Middleport, N. Y., care of G. F. Thompson, Middleport, representative, has been incorporated with a capital of \$500,000, to manufacture chemicals and chemical byproducts. The incorporators are E. Knapp and C. P. H. Schoellkopf.

THE LINCOLN STEEL CO., Woodhaven, L. I., N. Y., care of the United States Corporation Co., 65 Cedar St., New York, N. Y., representative, has been incorporated under Delaware laws with a capital of \$1,250,000, to manufacture steel products. The incorporators are Charles A. Follet, Woodhaven; George E. Follet, Richmond Hill, L. I.; and George W. Wheeler, East Orange, N. J.

THE UNITED STATES GLASS CORP., Pittsburgh, Pa., has been incorporated with a nominal capital of \$5,000, to manufacture glass products. The incorporators are W. W. McAdams, B. D. Booker and Frank J. Holub, 747 Union Arcade, Pittsburgh. The last noted is treasurer and represents the company.

THE KEN-O-TEX OIL CO., Muskogee, Okla., has been incorporated with a capital of \$25,000, to manufacture petroleum products. The incorporators are W. J. Chapman, L. R. Chambers and J. W. Patterson.

THE H. TYREE CHEMICAL CO., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., has been incorporated under Delaware laws with a capital of \$300,000, to manufacture chemicals and chemical byproducts.

New Publications

THE REHEATING OF COMPRESSED AIR. By C. R. Richards and J. N. Vedder. Bull. 130, published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

THE PRODUCTION OF NITRIC OXIDES AND OZONE BY HIGH-VOLTAGE ELECTRIC DISCHARGES. By Karl B. McEachron and R. H. George. Bull. 9, Engineering Experiment Station, Purdue University, Lafayette, Ind.

BOOKS

WOMEN IN CHEMISTRY: A STUDY OF PROFESSIONAL OPPORTUNITIES. Studies in Occupations, No. 4. The Bureau of Vocational Information, New York City. Here the student girl who is looking forward to chemistry as a life pursuit will find assembled an invaluable accumulation of information bearing on the problems in which she is most likely to be interested. This volume, as Dr. Herty quite truthfully points out in his letter of introduction, is "a comprehensive, conservative description of existing conditions, interspersed with sage advice as to the difficulties to be encountered, and with sound philosophy as to the benefits derived from devotion to a science whose goal is service to humanity." The text is divided into four parts. The first is a brief chapter on chemistry as a vocation, in which most stress is laid on the importance of chemistry in modern life and the need for adequately trained chemists. This is followed by a detailed analysis of positions in chemistry. In it are reviewed the opportunities offered by educational institutions, medical laboratories and hospitals, analytical and research laboratories of industry, of governmental and state institutions, and by several other related fields, such as library work and journalism. The third part of the book is devoted to training—both graduate and undergraduate. The text is concluded with a résumé of such important considerations as physical and mental requirements, salaries, means of securing positions, etc. An appendix contains much useful information on colleges and universities in which women may receive training in chemistry, prizes and grants available for research, fellowships and graduate scholarships open to women, scientific and technical publications and the national scientific societies for chemists.

BENN BROTHERS, London, published during September the third volume of H. H. Broughton's series on Electrical Handling of Materials, entitled "Electric Cranes." This volume, to which the two already published are introductory, deals in the most comprehensive manner with every kind of crane and crane mechanism. There are 300 illustrations and 65 tables. Another publication is "Recent Progress in Rubber Chemistry and Technology," by Dr. Philip Schidrowitz, also issued by Benn Brothers, which gives the results of research carried out during the last few years. This company also announces a new series of full-length monographs, each of which will be devoted to some specialized parts of the broad field of gas and fuel, three of which will be ready this fall. Of these the first, "The Administration and Finance of Gas Undertakings, With Special Reference to the Gas Regulation Act, 1920," by George Everts, consulting engineer, discusses the procedure necessary when applying for special acts of Parliament, the features of private bills, provisional orders, and so forth. A considerable amount of attention is given to financial features, the sliding scale, capital and revenue and the accounts of gas undertakings. The volume, in fact, is designed in such a way as to prove useful not only to technical gas officials but to directors, secretaries and accountants. In the second of these volumes, "Gasworks Recorders," the author, Dr. Leonard Levy, in addition to pointing out the innumerable uses to which recorders may profitably be put, so describes the construction and practical working of these instruments that all those who have to deal with them should have no difficulty in allocating and attending to defects on the spot. Almost every known form of recorder is dealt with, and there are 200 illustrations. Finally, "Modern Gasworks Chemistry," by Geoffrey Weyman, D.Sc., F.I.C., chief chemist to the Newcastle & Gateshead Gas Co., has primarily been written so as to form a companion volume to Meade's "Modern Gasworks Practice" and Hole's "Distribution of Gas." The two last-named volumes have now for some years provided for the requirements of the gasworks engineer and the distribution engineer respectively, but the equally important chemical phase of the science of gas making has been very inadequately provided for. Dr. Weyman has included in his volume every chemical test and process which is likely to be met with in even the largest gasworks.

Manufacturers' Catalogs

THE QUIGLEY FUEL SYSTEMS, INC., New York, calls attention to Bulletin A, just issued, giving a condensed description of the Quigley powdered coal system and appliances. The layout of a typical coal-milling plant is shown and the method of fuel distribution and control briefly described.

THE MERRIMAC CHEMICAL CO., Boston, Mass., has issued a pamphlet listing its products. This company is a manufacturer of chemicals for tanneries, paper mills, steel and wire works, textile mills, dye and chemical works, celluloid, smokeless powder and fertilizer manufacturers, artificial ice and refrigerating plants, foundries, brass finishers, engravers, etc.

THE L. R. CHRISTIE CO., Pittsburgh, Pa., has issued a catalog illustrating and describing its driers, calciners and coolers.

THE PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., in a new 16-page bulletin, No. 202, describes the company's line of double-suction single-stage centrifugal pumps, containing useful engineering data.

THE BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y., has issued an attractive catalog on vacuum drying, evaporation and other processes and the principal types of apparatus employed in modern industry, together with a brief description of "Buflovak" and "Bufokast" apparatus.

THE METALS COATING CO. OF AMERICA, Philadelphia, Pa., has issued an illustrated pamphlet describing the adaptability of the Schoop metal-coating process to commercial requirements, in a form of interest to industrial users.

AUTOMATIC & ELECTRIC FURNACES, LTD., 281 Gray's Inn Road, London, W. C. 1, England, calls attention to its new catalog dealing with Wild-Barfield automatic electric hardening equipments. Particular attention is given to the problems of heat-treatment and their solution by the use of electricity.

THE NASH ENGINEERING CO., South Norwalk, Conn., has issued Bulletin 25, on "The Jennings Hytor Vacuum Heating Pump Size M, Electric Motor Driven."

HERMAN A. HOLZ of New York has issued a pamphlet on "The Dommer Gas Calorimeter," which is a self-contained apparatus for the accurate and convenient determination of the heating value of gases.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at Richmond, Va., Dec. 7 to 9.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, 52 East 41st St., New York City Nov. 10—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting, Nov. 17—American Electrochemical Society, regular meeting, Dec. 1—Society of Chemical Industry, regular meeting, Dec. 8—American Chemical Society, regular meeting, Jan. 5—American Chemical Society, regular meeting, Jan. 12—Society of Chemical Industry, regular meeting, Perkin Medal, Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting, March 9—American Chemical Society, Nichols Medal, March 23—Society of Chemical Industry, regular meeting, April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting, May 4—American Chemical Society, regular meeting, May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting, May 18—Society of Chemical Industry, regular meeting, June 8—American Chemical Society, regular meeting.